WGMGROUP
Community Values. Inspired Futures

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MEMORANDUM

DATE: January 29, 2019

TO: City of Whitefish

FROM: Eric Anderson, P.E., CFM

RE: Floodplain No-Rise Analysis – 4-foot Wide Pedestrian Trail

Introduction

The City of Whitefish requested that WGM Group (WGM) provide floodplain modeling and no-rise analysis for a new proposed pedestrian trail connection. The new pedestrian trail will extend from the end of the existing path at the northeast corner of the Second St. Bridge, along the east side of the Whitefish River, and finally join with the existing "BNSF Loop" portion of pedestrian trail. Figure 1 shows the general trail alignment, and Attachment A contains site plan sheets by Bruce Boody Landscape Architect, Inc.

Due to space constraints along the trail corridor, the new trail will have a 4-foot wide gravel surface, which is narrower than the existing 8-foot wide paved pathway that ends near the Second Street bridge. The trail will be designed to be much more rugged than the existing paved pedestrian path and its layout and slopes will not be ADA compatible. As such, it will more easily contour with the terrain and will require minimal cut/fill for construction.

The new trail will pass through a portion of the regulatory floodplain for the Whitefish River. At the project location, the regulatory floodplain is Zone AE floodway and there is no floodfringe designation. Figure 2 shows a screenshot of the project area from the FEMA National Flood Hazard Layer (NFHL) map viewer. The project is located on FIRM panel 30029C11090J.

This memo serves to document the flood modeling process that WGM performed for the new pedestrian trail to prove that it will not affect the regulatory 100-year floodplain elevations, or base flood elevation (BFE). Certification of BFE's is included at the end of this memo.

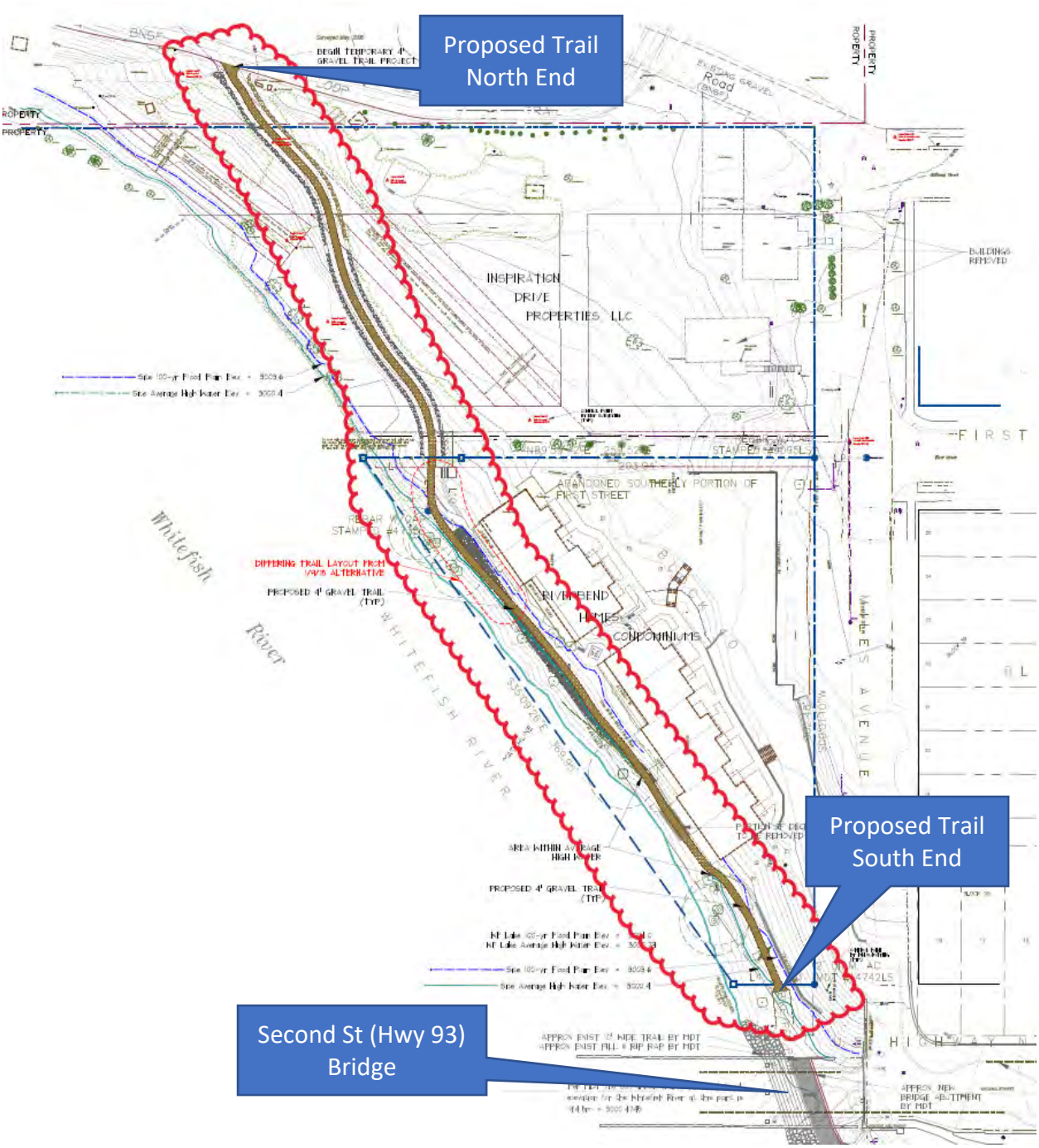

Figure 1. Proposed trail layout.

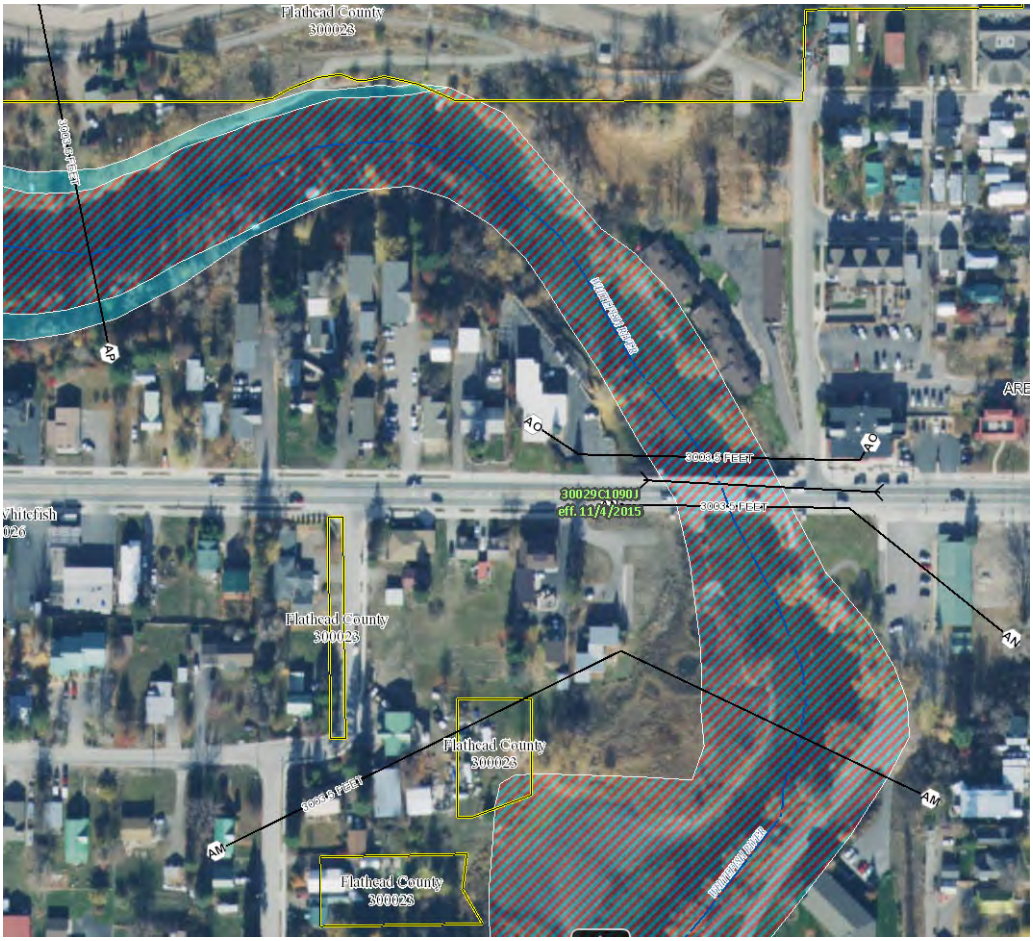

Figure 2. FEMA National Flood Hazard Layer (NFHL) map viewer.

Background

As part of the Hwy 93 improvement project that the Montana Department of Transportation that was completed in 2014, WGM provided floodplain permitting and flood modeling for the bridge replacement at the Whitefish River. The final report entitled *Whitefish West 2nd Street Bridge Permitting Report* dated May 9, 2012 was submitted with the floodplain permit application for the bridge. The bridge permitting report included a description of the HEC-RAS modeling performed for the new bridge. For reference, a full copy of this report has been included with the current memo as Attachment C. The modeling for the bridge permitting provided a no-rise analysis and certification.

HEC-RAS Modeling

Flood modeling and analysis for the new pedestrian trail built upon the modeling performed for MDT Whitefish West bridge replacement project. WGM treated the proposed conditions model from MDT Whitefish West bridge as the existing conditions model for the new pedestrian trail. The process to build the model for the Whitefish West bridge project is documented in the final *Whitefish West 2nd Street Bridge Permitting Report* in Attachment C. Note that the original project was

performed in SI units (MDT standard at that time), but the current project has been converted to US customary units.

To create the proposed conditions model for the new pedestrian trail, the geometry of cross sections 33.155 and 33.131 were modified to represent the proposed trail layout. Attachment B shows a plan view of cross sections 33.101, 33.131, 33.155, and 33.293 overlaid onto the trail layout. Figures 3 thru 6 show HEC-RAS screenshots of cross sections 33.131 and 33.155. The new 4-foot wide path grading can be seen in the proposed model cross sections in Figure 4 and 6 on the river-left side.

Other than the geometry of cross sections 33.131 and 33.155, no model parameters were changed between the existing conditions and proposed conditions models.

HEC-RAS Model Structure

Project File Name: Whitefish West 42 M Bridge 1-29-18
Project File: WfishWest42m_with_4ft_path.prj

Plan Files:

1. EXISTING CONDITIONS (.p02 file) – Existing conditions model runs using existing conditions geometry (.g20) and .f03 flow file.

2. PROPOSED CONDITIONS (.p05 file) – Proposed conditions model runs using proposed conditions geometry (.g21) and .f03 flow file.

Geometry Files:

1. EXISTING CONDITIONS (.g20) – Existing conditions model built from the proposed conditions model ordinally developed for the MDT Whitefish West bridge replacement project. All geometry and model parameters the same as original Whitefish West bridge model, except it was converted to US customary units from SI units.

2. PROPOSED CONDITIONS (.g21) – Proposed conditions geometry. Same as .g20 file, but XS's 33.131 & 33.155 are modified to represent 4-ft wide trail.

Steady Flow Files:

1. Whitefish River – Adjusted FIS Elevation (.f03) – Same flow file used by original MDT Whitefish West bridge replacement project. Uses FIS value for 100-year flow rate.

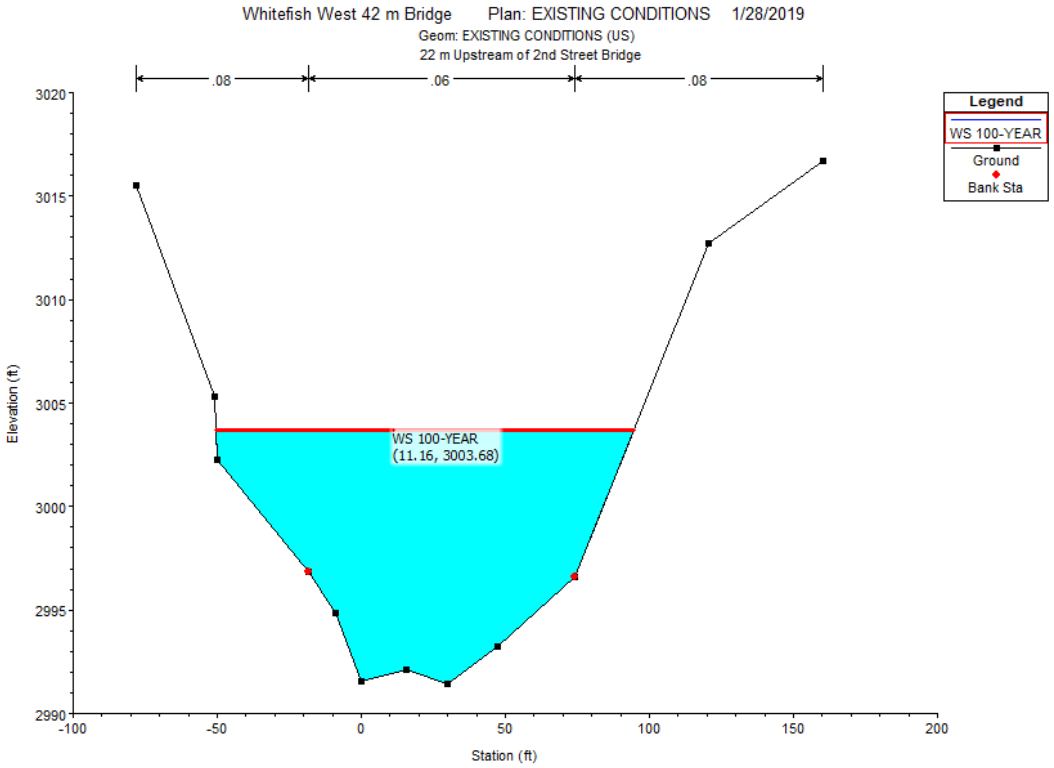

Figure 3. Existing condition model at XS 33.155. BFE = 3003.68.

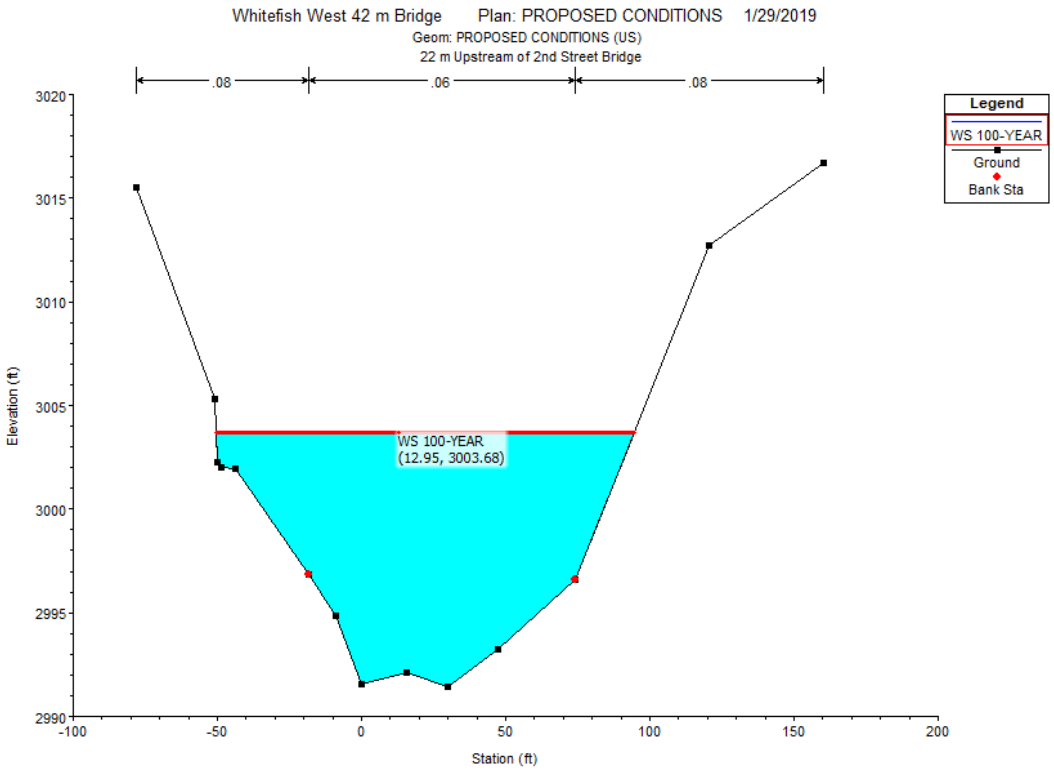

Figure 4. Proposed condition model at XS 33.155. BFE = 3003.68.

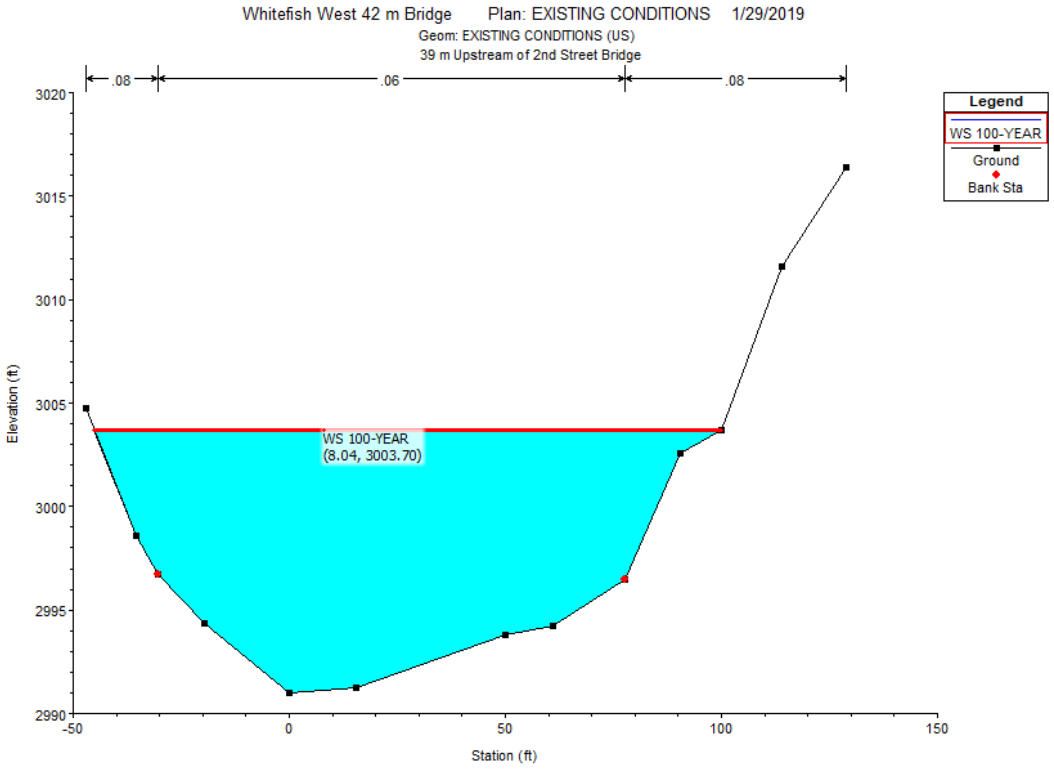

Figure 5. Existing condition model at XS 33.131. BFE = 3003.70.

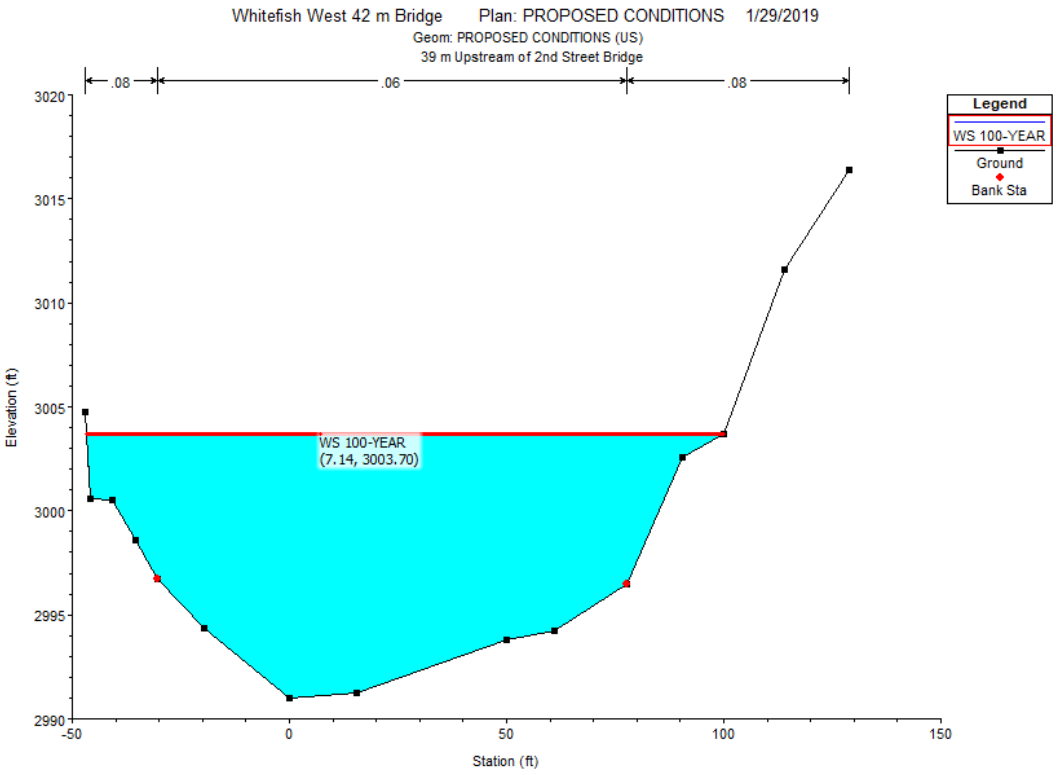

Figure 6. Proposed condition model at XS 33.131. BFE = 3003.70.

Model Results

Modeling results for the model cross sections near the new pedestrian trail are summarized in Table 1. As seen in the table, there is no change between the existing and proposed conditions model results for BFE's.

Model XS	Ex. Cond. Model (BFE)	Pr. Cond. Model (BFE)	Change (ft)
33.293	3003.77	3003.77	0.00
33.155	3003.70	3003.70	0.00
33.131	3003.68	3003.68	0.00
Bridge	Bridge	Bridge	Bridge
33.101	3003.66	3003.66	0.00
32.586	3003.35	3003.35	0.00

Table 1. HEC-RAS model BFE comparison for existing and proposed conditions.

No-Rise Certification

The HEC-RAS modeling for the proposed 4-foot wide pedestrian trail indicates that no rise to BFE's will occur due to the project's implementation. If the project is constructed as proposed, then no effect to BFE's is anticipated.

Memo Attachments

Attachment A – Project Plan Sheets, Bruce Boody Landscape Architecture
Attachment B – HEC-RAS Model Layout
Attachment C – MDT Whitefish West 2nd Street Bridge Permitting Report (2012)

ATTACHMENT A

ATTACHMENT A

PREFERRED ALTERNATIVE

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PH: 406-862-2386

Inspiration Drive
SURVEY BY:
EBY & Assoc. Surveyors
P.O. BOX 7144
KALISPELL, MT 59901
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Revisions:

RIVERBEND CONDO & MILES AVENUE BIKE/PEDESTRIAN TRAIL
CITY OF WHITEFISH

NORTH

SCALE: 1" = 40'

DATE: 09-06-18

JOB #: 10-24

REVISED CONCEPTUAL SITE PLAN
4' GRAVEL TRAIL
MILES AVE & RIVERBEND COMBINED

SHEET 1 OF 2

Surveyed May, 2006

BEGIN TEMPORARY 4' GRAVEL TRAIL PROJECT

LOOP

TRAIL

INSPIRATION DRIVE PROPERTIES, LLC

Site 100-yr Flood Plain Elev. = 3003.6

Site Average High Water Elev. = 3000.4

CONTROL POINT BY EBY SURVEYING (TYP)

N89°59'42"E 255.52'

231.84'

203.04'

ABANDONED SOUTH FIRST STREET

REBAR W/CAP STAMPED #4742LS

DIFFERING TRAIL LAYOUT FROM 1/9/18 ALTERNATIVE

PROPOSED 4' GRAVEL TRAIL (TYP)

RIVERBEND HOMES CONDOMINIUMS

Whitefish River

WHITEFISH RIVER

S35°09'26"E 369.95'

MATCHLINE

RIVERBEND HOMES CONDOMINIUMS

MILES AVENUE

S35°09'26"E 369.95'

MATCHLINE

RIVER

AREA WITHIN AVERAGE HIGH WATER

PORTION OF DECK TO BE REMOVED

PROPOSED 4' GRAVEL TRAIL (TYP)

WF Lake 100-yr Flood Plain Elev. = 3004.0

WF Lake Average High Water Elev. = 3000.79

Site 100-yr Flood Plain Elev. = 3003.6

Site Average High Water Elev. = 3000.4

CONTROL POINT BY F&H SURVEYING (TYP)

2" DIAM. AC MDT #14742LS

APPROX EXIST 10' WIDE TRAIL BY MDT

APPROX EXIST FILL & RIP RAP BY MDT

NOTE:

Per MDT the 50% annual chance (2 year) flood elevation for the Whitefish River at this point is 914.5m = 3000.4745

APPROX. NEW BRIDGE ABUTTMENT BY MDT

APPROX. NEW RETAINING WALL BY MDT

EXISTING KAY BELLER CITY PARK BOARDWALK & ASPHALT TRAIL

KAY BELLER

Whitefish River

PREFERRED ALTERNATIVE

0 10' 20' 40' 60'

BLOCK 39

BLOCK 3

BLOCK 23

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phone 406 862-4755
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RIVERBEND CONDO & MILES AVENUE BIKE/PEDESTRIAN TRAIL
CITY OF WHITEFISH

NORTH

SCALE: 1" = 20'

DATE: 09-06-18

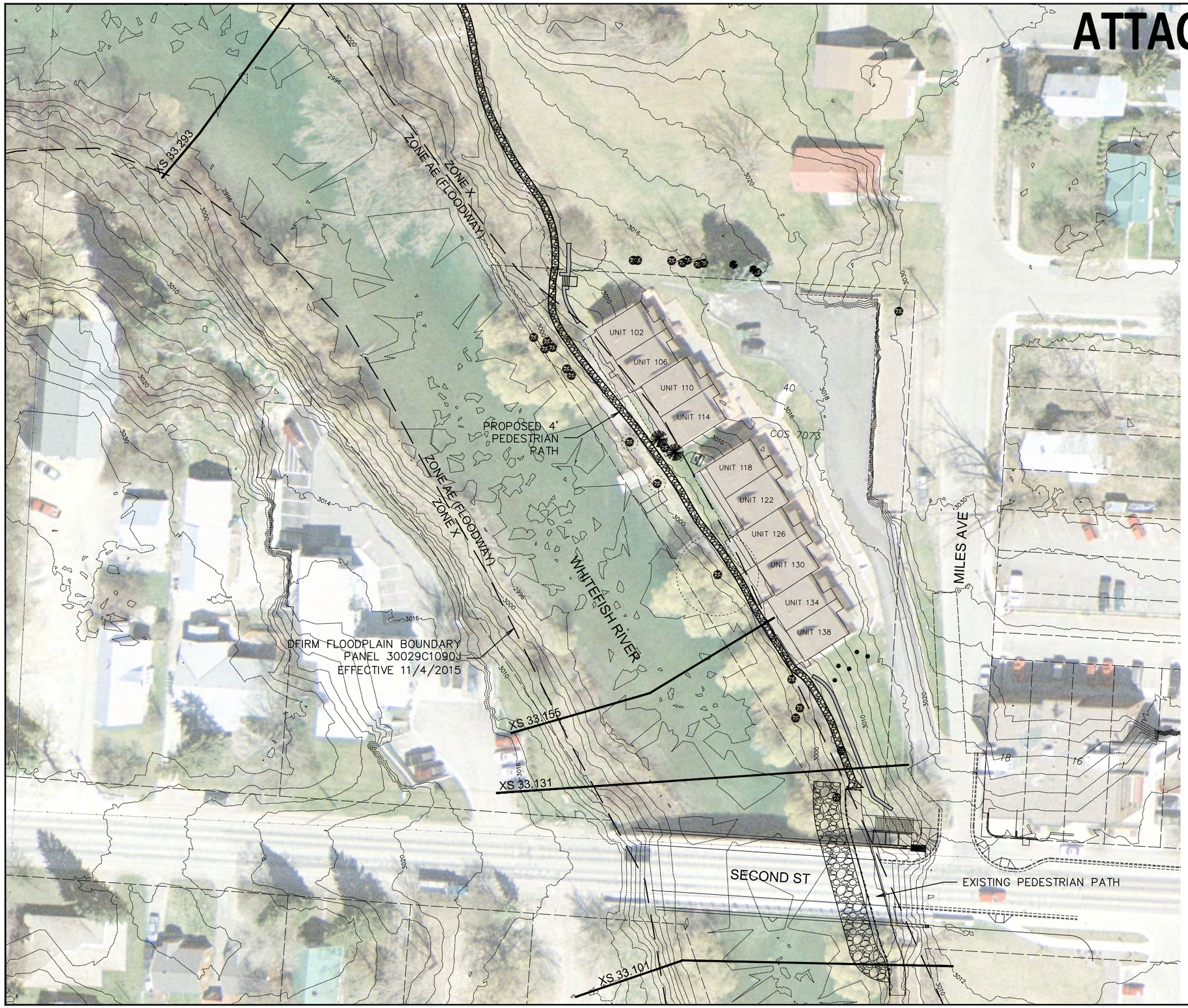
JOB #: 10-24

REVISED CONCEPTUAL SITE PLAN
4' GRAVEL TRAIL MILES AVE & RIVERBEND COMBINED

SHEET 2 OF 2

ATTACHMENT B

ATTACHMENT B



WGM GROUP
WWW.WGMGROUP.COM

PERMITTING
PLOTTED: 1/29/19
SAVED: 1/29/19

HEC-RAS MODEL LAYOUT
WHITEFISH RIVER PEDESTRIAN TRAIL
WHITEFISH, MONTANA

REVISIONS:

NO.	DESCRIPTION	DATE

PROJECT: 15-11-15
LAYOUT: FLOOD
SURVEYED: LIDAR
DESIGN: EFA
DRAFT: EDI
APPROVE: ...
DATE:

JANUARY 2019

SHEET 1 OF 1

FILE: W:\Projects\15\11\5\CAD Data\Design\15115-2EX-FLOOD.dwg

ATTACHMENT C

2nd STREET BRIDGE PERMITTING REPORT
WHITEFISH WEST
CBI-NH 5-3(96)128
UPN 2017

Whitefish, Montana

WGM Project No. 03-04-13

May 09, 2012

Prepared by:

WGM GROUP

Prepared By:
WGM Group, Inc.
1111 East Broadway
Missoula, MT 59802

This report was prepared by:

Kyle Thompson, P.E., CFM
Project Engineer

5/09/2012

QA/QC by:

Bruce Anderson
Senior Hydrologist

TABLE OF CONTENTS

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I. INTRODUCTION

Project Description and Study Objectives

This report addresses the hydrology and hydraulics of a proposed bridge replacement over the Whitefish River. The Whitefish West project will reconstruct and widen Highway 93 west of Whitefish, Montana. The project is owned and funded by the Montana Department of Transportation (MDT) and is being prepared in SI units (metric). This analysis maintains consistency with the overall project by using SI units, conversions to English units have been provided where appropriate.

The existing Highway 93/2nd Street bridge is approximately 70 years old and in need of replacement. The project will involve the demolition of the existing bridge and construction of a new bridge with a similar alignment and location. A temporary bridge will be constructed south of the permanent bridge to allow traffic to detour around the construction area. The detour bridge will be designed and permitted by the contractor and removed at the completion of the project.

Provisions of the City of Whitefish Floodplain Development Permit require the bridge to have its lowest elevation (the low chord) a minimum of two feet above the Base Flood Elevation (BFE) and not cause an increase in the BFE of more than 0.5 feet. In addition, the project will involve **development in the floodway which requires either a "no rise" certification or a Letter of Map** Revision (LOMR) if the project will cause changes to the BFE. WGM Group was retained by the MDT to provide design and permitting assistance in the form of hydrologic and hydraulic study to determine the effect of the proposed bridge on water surface elevations at the stream crossing. This report does not address geotechnical, foundation, or bridge structural design.

Project Location

The project is located in Flathead County, in the north half of Section 36, Township 31 North, Range 22 West. It is Highway 93 West out of Whitefish towards Eureka. A USGS vicinity map and aerial photo are provided in Appendix A.

II. SURVEY

Datums and Cross Sections

The vertical datum for the project is the North American Vertical Datum 1988 (NAVD88). The horizontal datum is Grid North of the Montana State Plan Coordinate System NAD83. Cross section data was obtained by TD&H Engineering of Kalispell, Montana. Mapping was completed with total station equipment and is based on control points established for the Whitefish West road reconstruction project.

Cross section locations were selected prior to field collection by the survey crew. A total of 35 cross sections were chosen, beginning downstream of Columbia Avenue and extending upstream to Whitefish Lake. The original limits of the project were much larger and included Highway 93 west of Whitefish, through Whitefish, and south of Whitefish. Numerous river crossings occur in this corridor, several of which were proposed for replacement. Although the project was ultimately divided into separate, smaller segments, the extents of the cross section survey reflect the scope of the original project and therefore are included in the analysis.

Although they are included in the analysis this report does not address all of the crossings, only the Highway 93/2nd Street crossing.

Flood Insurance Rate Map (FIRM)

The project site is located between cross sections Q and R on FIRM map number 30029C1090G, a recently updated map from the Flathead County Flood Insurance Study (FIS) with an effective date of September 28, 2007. The Whitefish River in this area is classified as Zone AE which is an area with a base floodplain where the base flood elevations are provided. The Whitefish River also has a designated floodway which is coincident with the base flood boundary at the project site. A copy of the effective FIRM panel is located in Appendix B.

III. HYDROLOGY

Discharge Estimation

The Whitefish River flows southeast out of Whitefish Lake through the city of Whitefish. The 2007 Flathead County FIS lists the total drainage area of the Whitefish River at Whitefish as 125 square miles with a peak discharge of 1,740 cubic feet per second (cfs) for the one-percent annual chance flood event. In order to obtain a floodplain development permit for this project, it is necessary to analyze the Whitefish River using the flow values published in the FIS. Table 1 lists the design discharge estimate used in the analysis.

Table 1. Design Discharge Estimate

Q_{100}	**1,740 cfs**	**49.271 m^3/s**

IV. HYDRAULICS

Methodology and Parameters

The hydraulic modeling software HEC-RAS (version 4.1.0) was used to determine the effect of the proposed bridge on the water surface elevation compared to the existing bridge for the one-percent annual chance flood event at the project site. HEC-RAS uses the step-backwater method to calculate water surface elevations assuming flow is gradually varied. This software is approved by both FEMA and the Montana Department of Natural Resources (DNRC) for use in flood studies. In addition, it is the software that DNRC district engineers who review flood studies for local communities are most familiar with.

Modeling parameters used to prepare the flood study include the mapped cross sections, surface roughness factors (Manning's "n"), peak discharge estimate, and boundary conditions. Horizontal and vertical data from the cross sections was entered into HEC-RAS to define the reach of the Whitefish River being studied. After defining the location and orientation of the cross sections, the bank stations were identified and Manning's "n" values were assigned to the channel and overbank areas of each cross section. The Flathead County FIS was referenced for Manning's "n" values.

The Whitefish River is a natural stream with "roughness values ranging from 0.024 to 0.045 in the channel and from 0.035 to 0.080 in the overbank areas." (FEMA 2007, p. 32) While **Manning's "n" values of 0.04 for the channel and 0.08 for the overbank areas were originally**

selected to represent the existing conditions, it was found that the water surface elevations in the FIS were most closely approximated in the **model with a channel "n" value of 0.06.** ***Manning's "n" values of 0.06 (channel) and 0.08 (overbank) were used in this analysis.***

Flow within HEC-RAS can be modeled as either steady or unsteady. Steady flow implies that velocity, discharge, and flow depth remain constant at any cross section and is most appropriate for flood studies. Unsteady flow implies that these parameters are changing with time. In addition, assuming steady flow is conservative compared to assuming unsteady flow because the storage effects of the channel are not accounted for (Akan 2006, p. 315). *For this analysis, flow during the period of peak discharge is assumed to be steady.*

Within a steady flow analysis, HEC-RAS offers three options for the flow regime: subcritical, supercritical, and mixed flow. For the purposes of a flood study, a subcritical flow regime is most applicable as it will give the highest possible water surface elevations. *A subcritical flow regime was used for this analysis.*

In order for the step-backwater method to calculate a water surface profile, a boundary condition must be specified based on the flow regime. There are four options to select from as the boundary condition for the subcritical flow regime; Known Water Surface, Critical Depth, Normal Depth, and Rating Curve. The option most applicable to this analysis is the Known Water Surface because the existing conditions model was calibrated to closely match the FIS. Calculations for determining the Known Water Surface elevation are provided in Appendix E. *A Known Water Surface elevation was used in this analysis as the boundary condition.*

HEC-RAS modeling parameters are summarized in Table 2.

Table 2. Summary of Modeling Parameters

Manning's "n" - Main Channel	**0.060**	
Manning's "n" - Overbank Areas	**0.080**	
Flow Type	**Steady**	
Flow Regime	**Subcritical**	
Boundary Condition	**Known Water Surface**	
Known Water Surface Elevation at furthest downstream cross section (1% Annual Chance Flood Event)	**3,001.06 ft**	**914.72 m**

Bridge Hydraulics – Highway 93/2nd Street Crossing

The existing bridge at Highway 93/2nd Street is a three-span structure with a total length of 53.34 meters and a width of 12.892 meters. The bridge alignment crosses the Whitefish River at a skew angle of approximately 19° and abutments are vertical concrete. Two piers, located in the river, complete the structure. The bridge crossing is located on a generally straight section of river; a 90° bend occurs approximately 190 meters upstream and a 105° bend occurring approximately 90 meters downstream.

The one percent annual chance flood event is contained within the river channel both upstream and downstream of the Highway 93/2nd Street crossing despite the river being highly developed

on both sides of its banks. The river channel is stable throughout the study reach, experiencing minimal channel migration. Appendix F contains aerial photos of the Highway 93/2nd Street crossing from 1990, 2004 and 2009. Review of the aerial photos shows the river planform to be laterally stable. The roadway on both sides of the river is well above the normal water surface elevation. In fact, the approach roads do not overtop during floods equal to the 0.2% annual chance event.

The first model built was an existing conditions model using the surveyed cross section data. Two cross sections were added to the 35 surveyed cross sections for a total of 37 cross sections in the model. The two additional cross sections were created by copying surveyed cross sections; the copied cross sections are located at RS 33.101 and RS 33.972. Stream crossings were added using the Bridge Culvert Data editor. These crossings occur at Columbia Avenue (RS 31.393), Spokane Avenue (RS 31.679), Baker Avenue (RS 32.325), Riverside Park Footbridge (RS 32.584), Highway 93/2nd Street (RS 33.110), and the Burlington Northern Railroad (RS 33.976).

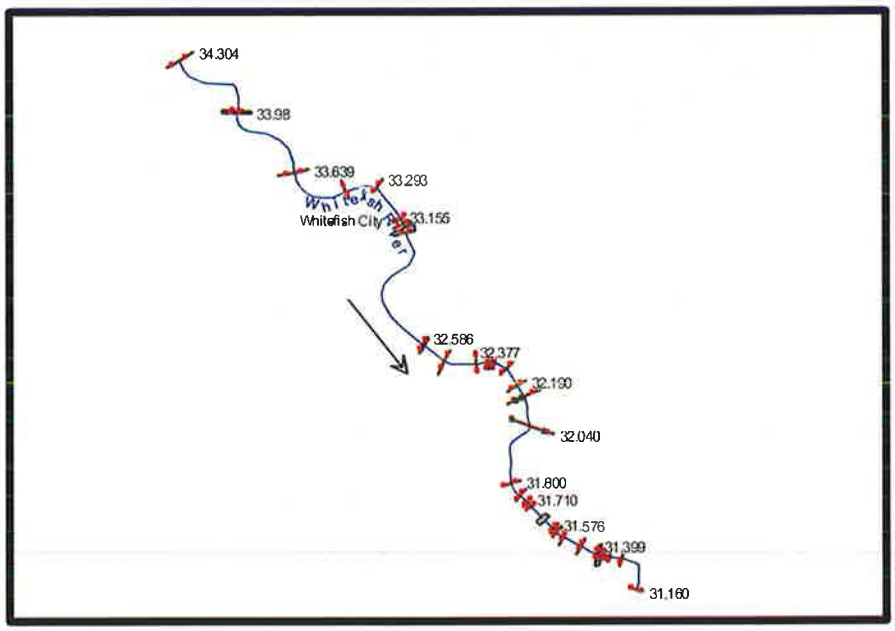


Figure 1 – HEC-RAS Model Geometry

The proposed bridge is a single-span structure with a 42.0 meter beam length. Several bridge lengths and configurations were considered, including multi-span structures with intermediate piers. Ultimately, it was determined that the greatest value to the project and to the river was to construct a shorter bridge that would negate the need for piers, thus minimizing disturbance to the river. The new bridge incorporates a pedestrian trail on the east bank of the Whitefish River, extending an existing trail that currently terminates at the south face of the existing bridge. The vertical and horizontal alignments for the proposed bridge are constrained by development in the project area and therefore are not subject to much change. The horizontal alignment remains unchanged, including the 19° skew to the river. The vertical alignment has been raised to allow the pedestrian trail to pass under the bridge while maintaining 2.438 meters (8 feet) of clearance between the trail and bridge beams. Both sides of the bridge are proposed to have sloping abutments with the east side of the bridge also incorporating a vertical abutment face and retaining walls to create a 3.3-meter wide level bench for the pedestrian trail.

Bridges in both the existing conditions model and proposed model were analyzed using low flow computational methods, meaning that flow is below the low chord. Of the four low flow methods available in HEC-RAS, only the Energy (Standard Step) method was used. The program continues computations upstream of the bridge using the highest upstream energy elevation as a result of selecting Highest Energy Answer in the Bridge Modeling Approach Editor.

Bridge Hydraulics – Results

The existing conditions model (Plan 03) calculated the water surface elevation at the upstream face of the Highway 93/2nd Street Bridge (RS 33.110 BR U) to be 915.52 meters (3,003.67 feet). The proposed 42-meter bridge model (Plan 04) calculated the water surface elevation at RS 33.110 BR U to be the same as the existing bridge model, or 915.52 meters. The model **comparison shows that the proposed bridge causes "no rise" in the water surface elevation** at the Highway 93/2nd Street crossing. The floodway data table from the 2007 FIS lists the base flood elevation (BFE) at the Highway 93/2nd Street crossing as 915.47 meters (3,003.5 feet). The difference between the modeled water surface elevation based on surveyed cross sections and the FIS is 0.05 meters (0.16 feet).

Additional hydraulic parameters evaluated in the model include bridge open area, flow area, total velocity, and total shear stress. The Highway 93/2nd Street crossing was compared to the rest of the river to determine the effect of the proposed bridge relative to the remainder of the study reach. As would be expected, areas for the bridge opening and flow were reduced. While the bridge open area decreased by approximately 13% the flow area decreased disproportionately at only 4%. Figure 2 illustrates the reduction in flow area at the Highway 93/2nd Street crossing. The consequence of this was an increase in water velocity (+4%) although total shear stress went down (-2%). Removal of the existing piers is responsible for reducing local velocities which in turn reduced total shear stress. Profile plots of each of these parameters for both the existing (Plan 03) and proposed (Plan 04) condition illustrate that the bridge section is within the normal range of values for this reach. In fact, there are sections of river further downstream with much smaller flow areas and accompanying higher velocities and shear stresses. The conclusion reached from this comparison is that the new bridge does not represent an abnormal restriction to the river and therefore is not expected to pose a risk to the stability of the river. Profile plots of water surface elevation, flow area, total velocity, and total shear stress along with velocity distribution plots for the upstream face of the bridge are provided in Appendix G.

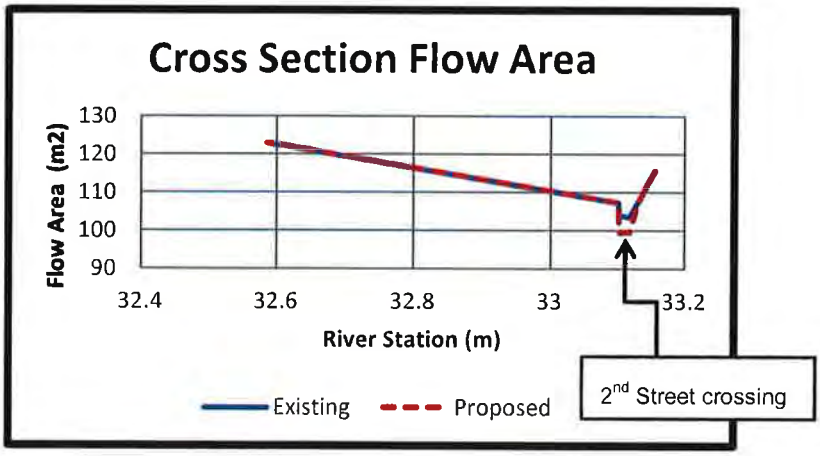


Figure 2

A summary of the water surface elevations and total velocities in the vicinity of the Highway 93/2nd Street crossing for the existing and proposed conditions is given in Table 3.

Table 3. Summary of Modeling Results

	Existing 53.34-meter Bridge		Proposed 42.00-meter Bridge	
River Station	**Water Surface Elevation (m)**	**Total Velocity (m/s)**	**Water Surface Elevation (m)**	**Total Velocity (m/s)**
33.155	915.53	0.43	915.53	0.43
33.131	915.52	0.46	915.52	0.46
33.109 BR U	915.52	0.48	915.52	0.50
33.109 BR D	915.51	0.47	915.51	0.50
33.101	915.51	0.46	915.51	0.46
32.586	915.42	0.40	915.42	0.40

Scour Calculations and Riprap Sizing

HEC-RAS was also used to model the anticipated abutment scour at the proposed Highway 93/2nd Street crossing in accordance with Hydraulic Engineering Circular (HEC) 18, *Modeling Scour at Bridges*, published by the Federal Highway Administration (FHWA).

A bed sample from the Whitefish River was obtained for analysis on February 26, 2007. The upper 0.24 meters (9.45 inches) of bed material was classified as well-graded sand with gravel, the D_{50} particle size is approximately 2.4 mm (0.095 inches) and the D_{95} particle size is approximately 25 mm (0.98 inches). These values were used for scour computations within HEC-RAS. Maximum anticipated scour for the abutments was calculated using the Froehlich equation and determined to be 1.38 meters for the eastern abutment and 1.67 meters for the western abutment. HEC-RAS output files for abutment scour are included in Appendix H.

Contraction scour and riprap stability were calculated by hand and are also included in Appendix H. The critical velocity for the D_{50} particle size material was computed for the left overbank, main channel, and right overbank areas. The critical velocity is greater than the predicted velocity upstream of the Highway 93/2nd Street crossing for the 1% annual chance flood event, therefore clear-water scour is the most likely form of contraction scour. Follow-up calculations show that contraction scour is not anticipated.

HEC 15, *Design of Roadside Channels with Flexible Linings* was referenced to verify riprap size and stability for both the bed and side slopes of the new crossing. Calculations show that MDT Class I riprap, with a D_{50} of 0.20 meters (8 inches), at 1.5H:1.0V side slopes is adequate for the design.

Errors, Warnings, and Notes

There were no errors generated during either of the model runs (Plans).

One warning was recurring at 12 cross sections for both Plans. It was *The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections*. The calculated conveyance ratio, change in water surface elevations, and change in energy grade elevations were checked for each of the 12 cross sections. There is one cross section where the change in water surface elevation and change in energy grade elevation is greater than 0.3 meters (1.0 feet). This occurs at the Spokane Avenue culverts (RS 31.689) which is over 1,400 meters downstream of the Highway 93/2nd Street crossing. The nearest cross sections with this warning are over 500 meters upstream and over 700 meters downstream of the Highway 93/2nd Street crossing. As a result of these distances, this warning is not considered to adversely affect the quality of this model in the vicinity of the Highway 93/2nd Street crossing.

The warning *Divided flow computed for this cross-section* was issued at one cross section (RS 32.145). The cross-section is in an area of an historic side channel and is over 900 meters downstream of the Highway 93/2nd Street crossing. This warning is not considered to adversely affect the quality of the model in the vicinity of the Highway 93/2nd Street crossing.

Two notes were received in both Plans. They are 1) *Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used* and 2) *The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height of the culvert.* Notes are not considered to adversely affect the quality of the model.

V. RECOMMENDATIONS

This analysis shows that the proposed Highway 93/2nd Street Bridge causes **"no rise"** in the water surface elevation at the stream crossing. The minimum low chord elevation for this configuration is recommended to be 916.130 meters (3,005.67 feet) to provide the necessary 0.61 meters (2 feet) of freeboard. The actual low chord elevation is 917.283 meters, 1.153 meters (3.78 feet) higher due to the clearance requirements of the pedestrian trail at the east abutment. A summary of the recommended bridge design parameters is provided in Table 4.

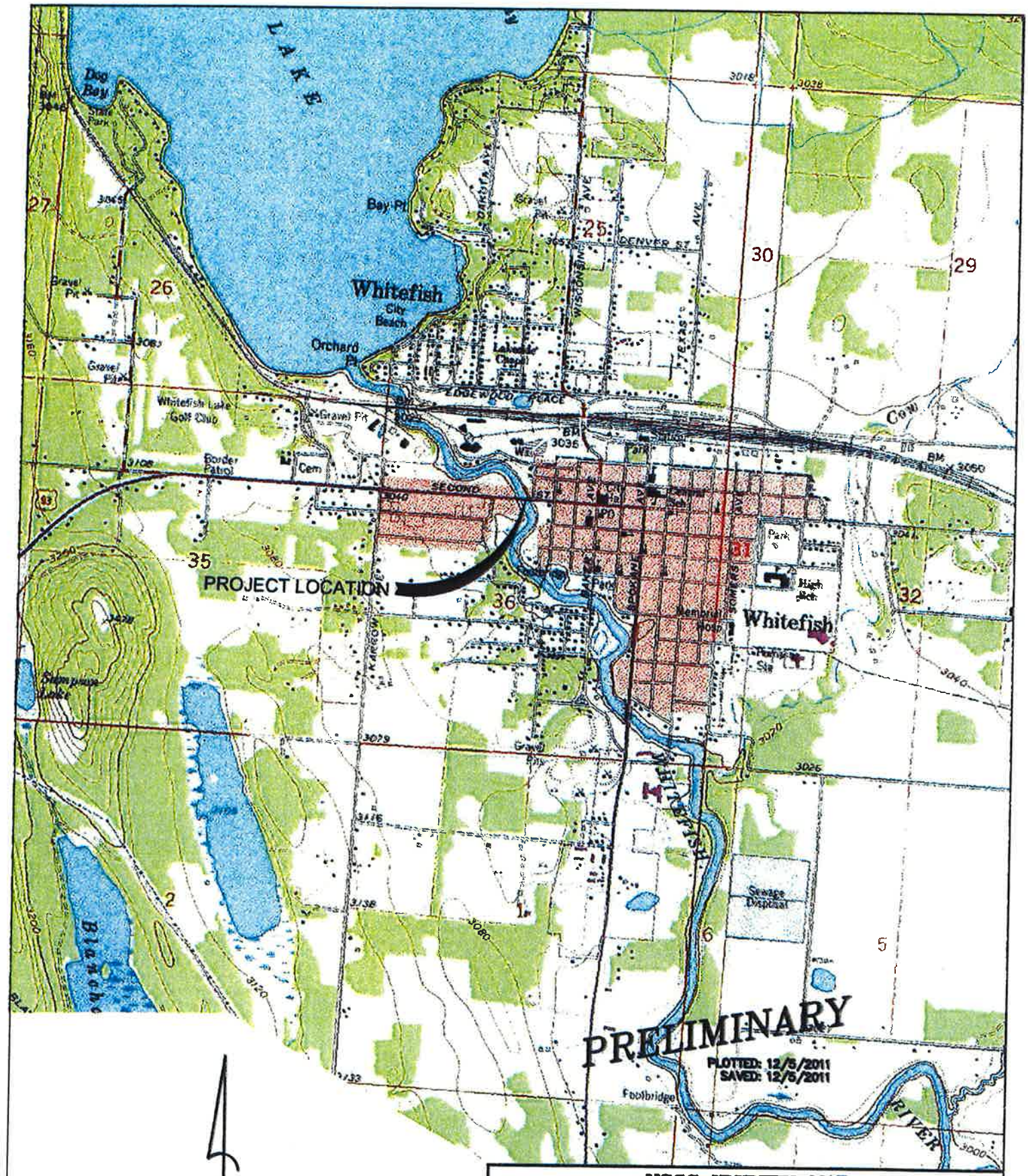
Table 4. Summary of Recommended Bridge Design Parameters

Low Chord Elevation (Minimum)	**916.13 m**
Bridge Span (Beam Length)	**42 meters**
Water Surface Rise	**0.0 meters**
Max. Total Velocity	**0.50 m/s**
Change in Total Velocity	**+0.02 m/s**
Riprap Size (D50)	**0.20 meters**
Abutment Side Slope	**1.5H:1.0V**

VI. LIST OF REFERENCES

1. Akan, A.O. *Open Channel Hydraulics.* Butterworth-Heineman, 2006.
2. Chow, V.T. *Open Channel Hydraulics*. McGraw-Hill Companies, 1959.
3. **"Flood Insurance Study: Flathead County, Montana, and Incorporated Areas. Volume 1 of 2."** Federal Emergency Management Agency, September 28, 2007.
4. Haestad Methods, Gary Dyhouse, Jennifer Hatchett, Jeremy Benn, *Floodplain Modeling Using HEC-RAS,* 1st ed. Haestad Press, 2003.
5. "HEC-RAS Hydraulic Reference Manual, Version 4.1.0", United States Army Corps of Engineers, January 2010.
6. **"Design of Roadside Channels with Flexible Linings." Hydraulic Engineering Circular** Number 15, 3rd Edition. Federal Highway Administration, September 2005.
7. **"Evaluating Scour at Bridges." Hydraulic Engineering** Circular Number 18, 4th Edition. Federal Highway Administration, May 2001.

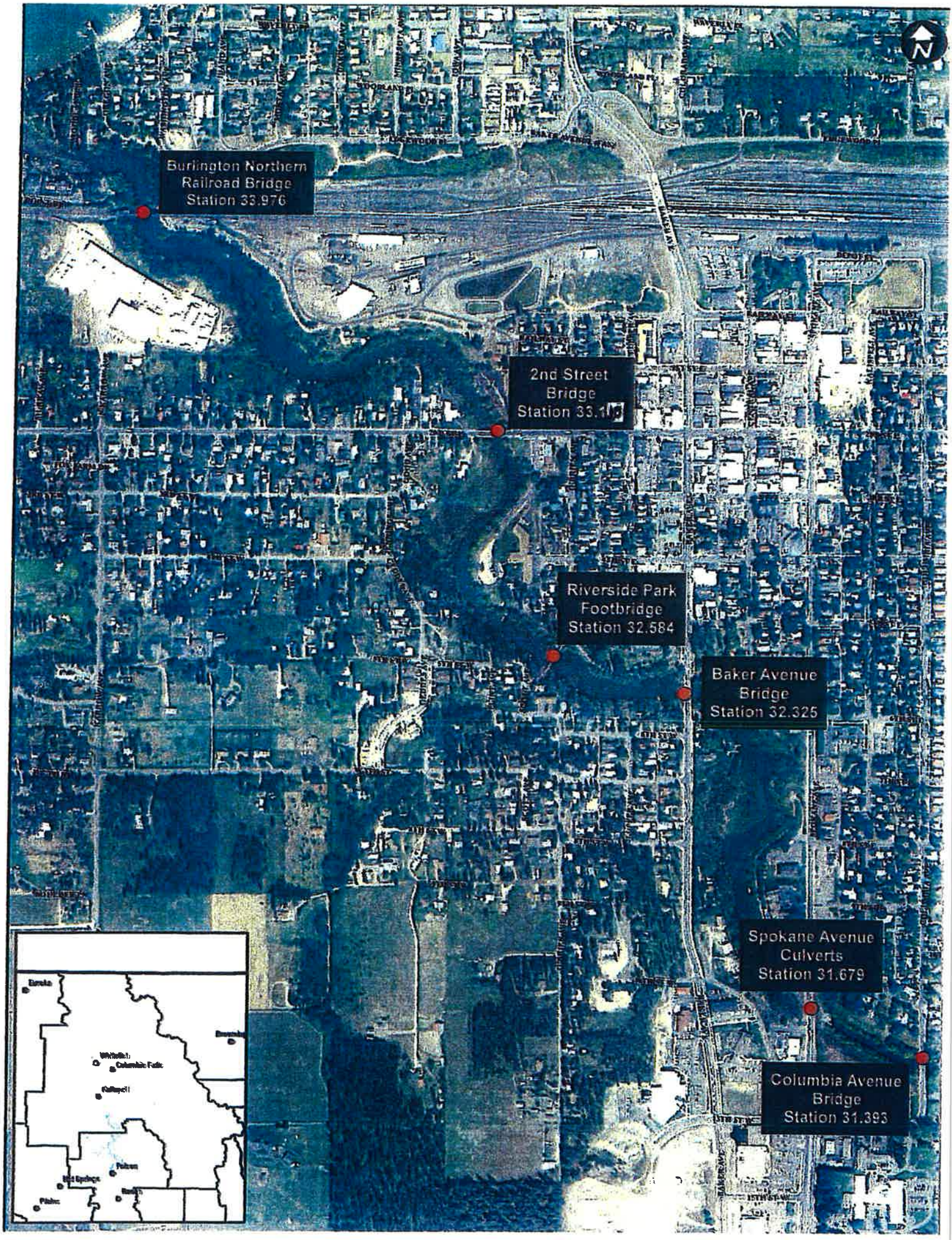
APPENDIX A
USGS Vicinity Map and Aerial Photo



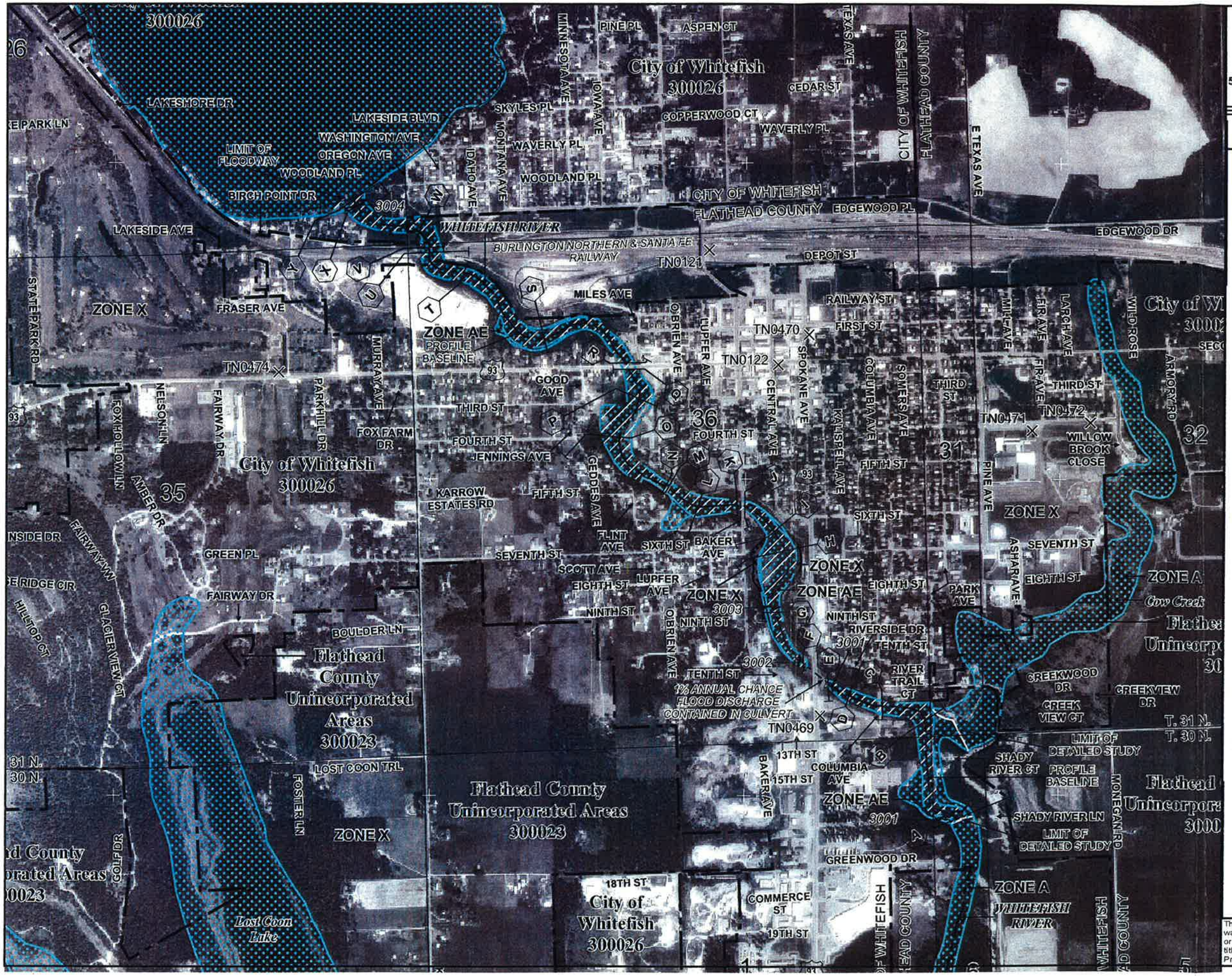
USGS VICINITY MAP
WHITEFISH RIVER BRIDGE CROSSING–WHITEFISH WEST PROJECT
WHITEFISH, MONTANA

WGM GROUP
ENGINEERING • SURVEYING • PLANNING
1111 EAST BROADWAY • MISSOULA, MT 59802
TEL: 406-728-4611 • FAX: 406-728-2476

PROJECT:	03-04-13
FILE No:	030413USGS.dwg
FILE PATH	
LAYOUT:	USGS
SURVEYED:	USGS
DESIGN:	KLT
DRAFT:	EDI
APPROVED:	---
DATE:	DECEMBER 2011
SHEET	1 OF 1 SHEETS


Burlington Northern
Railroad Bridge
Station 33.976
2nd Street
Bridge
Station 33.1
Riverside Park
Footbridge
Station 32.584
Baker Avenue
Bridge
Station 32.325
Spokane Avenue
Culverts
Station 31.679
Columbia Avenue
Bridge
Station 31.393
N

APPENDIX B
FEMA Map (FIRM)



NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1090G

FIRM

FLOOD INSURANCE RATE MAP

FLATHEAD COUNTY, MONTANA AND INCORPORATED AREAS

PANEL 1090 OF 3525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FLATHEAD COUNTY	300023	1090	G
WHITEFISH, CITY OF	300028	1090	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
30029C1090G
EFFECTIVE DATE

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX C
HEC-RAS Output (Existing Conditions)

WfishWest42m.rep

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X     X
X     X  X        X           X   X    X    X    X
XXXXXXX  XXXX     X       XXX XXXX     XXXXXX    XXXX
X     X  X        X           X  X     X    X        X
X     X  X        X    X      X   X    X    X        X
X     X  XXXXXX    XXXX       X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Whitefish West 42 m Bridge
Project File : WfishWest42m.prj
Run Date and Time: 12/23/2011 11:03:40 AM

Project in SI units

Project Description:
`Whitefish River, Whitefish, MT, Kevin Slovarp, WGM Group, Proj. 030606, Dec. 21, 2005

PLAN DATA

Plan Title: EC Rough & Adjusted FIS Elevation
Plan File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.p03

Geometry Title: Whitefish River - Existing Cond. Rough
Geometry File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.g17

Flow Title : Whitefish River - Adjusted FIS Elevation
Flow File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.f03

Plan Summary Information:

Number of:	Cross Sections	= 35	Multiple Openings	=	0
	Culverts	= 1	Inline Structures	=	0
	Bridges	= 5	Lateral Structures	=	0

Computational Information

Water surface calculation tolerance	= 0.01
Critical depth calculation tolerance	= 0.01
Maximum number of iterations	= 20
Maximum difference tolerance	= 0.3
Flow tolerance factor	= 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Whitefish River - Adjusted FIS Elevation
Flow File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.f03

Flow Data (m3/s)

River	Reach	RS	10-YEAR	50-YEAR	100-YEAR	500-YEAR	2-YEAR
Whitefish River	Whitefish City	34.304	36.246	45.732	49.271	59.182	22.9

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Whitefish River	Whitefish City	10-YEAR		
			Known WS = 914.4	
Whitefish River	Whitefish City	50-YEAR		
			Known WS = 914.64	
Whitefish River	Whitefish City	100-YEAR		
			Known WS = 914.72	
Whitefish River	Whitefish City	500-YEAR		
			Known WS = 914.94	
Whitefish River	Whitefish City	2-YEAR		
			Known WS = 914.2	

GEOMETRY DATA

Geometry Title: Whitefish River - Existing Cond. Rough
Geometry File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.g17

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 34.304

INPUT
Description: 61.089 meters downstream of Whitefish Lake
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-46.198	919.091	-44.313	918.982	-34.124	917.458	-14.452	915.418	-11.643	914.252
-11.176	913.47	-4.99	912.923	0	912.375	10.047	912.48	14.428	912.863
22.288	912.989	26.918	912.631	31.496	912.45	37.748	913.12	41.343	913.433
51.005	914.407	53.387	915.887	66.911	916.266				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

-46.198	.08	-11.176	.06	41.343	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-11.176	41.343	337.355	325.924	331.97	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.98

INPUT
Description: Upstream Face of Burlington Northern Railroad Bridge
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.549	22.391	8.002	8.002	.1	.3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 33.976

INPUT
Description: Burlington Northern Rail Road Bridge
Distance from Upstream XS = .001
Deck/Roadway Width = 8
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 14

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-42.654	925.82	912	-42.654	925.82	923.19	-25.309	925.84	923.21
-22.915	925.84	923.21	-13.216	925.84	923.21	-10.878	925.84	923.21
12.335	925.85	923.21	14.594	925.85	923.21	24.462	925.85	923.22
26.836	925.85	923.22	43.784	925.86	923.23	46.515	925.86	923.23
58.734	925.87	923.24	58.734	925.87	912			

Upstream Bridge Cross Section Data
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.549	22.391	.1	.3

Downstream Deck/Roadway Coordinates
num= 14

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord

-42.954	925.82	912	-42.954	925.82	923.19	-25.683	925.84	923.21
-23.289	925.84	923.21	-13.613	925.84	923.21	-11.275	925.84	923.21
11.96	925.85	923.21	14.219	925.85	923.21	24.159	925.85	923.22
26.533	925.85	923.22	43.398	925.86	923.23	46.129	925.86	923.23
58.411	925.87	923.24	558.411	925.87	912			

Downstream Bridge Cross Section Data
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.549	22.391	.1	.3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 5

Pier Data
Pier Station Upstream= -24.112 Downstream= -24.486

Upstream num= 2			
Width	Elev	Width	Elev
2.394	912	2.394	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.394	912	2.394	923.21

Pier Data
Pier Station Upstream= -12.047 Downstream= -12.444

Upstream num= 2			
Width	Elev	Width	Elev
2.338	912	2.338	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.338	912	2.338	923.21

Pier Data
Pier Station Upstream= 13.465 Downstream= 13.09

Upstream num= 2			
Width	Elev	Width	Elev
2.259	912	2.259	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.259	912	2.259	923.21

Pier Data
Pier Station Upstream= 25.649 Downstream= 25.346

Upstream num= 2			
Width	Elev	Width	Elev
2.374	912	2.374	923.22
Downstream num= 2			

Width	Elev	Width	Elev
2.374	912	2.374	923.22

Pier Data
Pier Station Upstream= 45.15 Downstream= 44.764
Upstream num= 2

Width	Elev	Width	Elev
2.731	912	2.731	923.23

Downstream num= 2

Width	Elev	Width	Elev
2.731	912	2.731	923.23

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.63	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.62	E.G. Elev (m)	915.63	915.63
Q Total (m3/s)	49.27	W.S. Elev (m)	915.62	915.61
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.39	913.39
Q Weir (m3/s)		Max Chl Dpth (m)	3.56	3.55
Weir Sta Lft (m)		Vel Total (m/s)	0.45	0.45
Weir Sta Rgt (m)		Flow Area (m2)	109.15	109.05
Weir Submerg		Froude # Chl	0.10	0.10
Weir Max Depth (m)		Specif Force (m3)	145.18	144.94
Min El Weir Flow (m)	921.17	Hydr Depth (m)	2.10	2.10
Min El Prs (m)	923.24	W.P. Total (m)	60.67	62.59
Delta EG (m)	0.00	Conv. Total (m3/s)	2999.5	2966.8
Delta WS (m)	0.00	Top Width (m)	52.05	52.03
BR Open Area (m2)	671.88	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.45	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	4.76	4.71

Br Sel Method	Energy only	Power Total (N/m s)	-2065.36

-2065.36

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.72	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.71	E.G. Elev (m)	914.72	
914.71				
Q Total (m3/s)	22.90	W.S. Elev (m)	914.71	
914.71				
Q Bridge (m3/s)	22.90	Crit W.S. (m)	913.03	
913.02				
Q Weir (m3/s)		Max Chl Dpth (m)	2.65	
2.65				
Weir Sta Lft (m)		Vel Total (m/s)	0.34	
0.35				
Weir Sta Rgt (m)		Flow Area (m2)	66.42	
66.38				
Weir Submerg		Froude # Chl	0.08	
0.09				
Weir Max Depth (m)		Specif Force (m3)	64.51	
64.37				
Min El Weir Flow (m)	921.17	Hydr Depth (m)	1.58	
1.58				
Min El Prs (m)	923.24	W.P. Total (m)	46.84	
47.86				
Delta EG (m)	0.00	Conv. Total (m3/s)	1547.0	
1535.6				
Delta WS (m)	0.00	Top Width (m)	42.03	
42.01				
BR Open Area (m2)	671.88	Frctn Loss (m)	0.00	
0.00				
BR Open Vel (m/s)	0.35	C & E Loss (m)	0.00	
0.00				
Coef of Q		Shear Total (N/m2)	3.05	
3.02				
Br Sel Method	Energy only	Power Total (N/m s)	-2065.36	

-2065.36

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.972

INPUT
Description: Downstream Face of Burlington Northern Railroad Bridge
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.147	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.549	22.391	328.925	329.729 343.158	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.639

INPUT
Description: Lumber Yard
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-58.671	920.165	-54.054	920.242	-43.575	917.083	-36.738	913.774	-30.97	913.338
-22.859	912.537	-22.751	913.269	-18.982	911.446	-10.811	911.946	0	911.877
7.31	912.005	18.367	913.008	19.85	913.374	35.311	915.121	48.952	922.805
55.02	923.624								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-58.671	.08	-30.97	.06	19.85	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-30.97	19.85	184.125	230.908 267.49	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.408

INPUT
Description: Section at Arc Shaped Railroad Building
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.511	916.86	-37.556	915.504	-27.515	914.71	-23.336	913.901	-21.536	913.492
-15.163	912.688	-7.614	911.912	0	911.652	6.52	912.67	11.26	913.53
18.797	914.586	21.925	915.493	25.865	915.859	28.978	917.106	31.688	917.337

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.511	.08	-21.536	.06	11.26	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-21.536	11.26	133.292	115.036 97.73	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.293

INPUT
Description: SW of Railroad Holding Ponds
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-36.223	919.226	-25.107	916.178	-20.991	915.858	-16.031	914.04	-12.483	913.418
-6.87	912.622	-5.075	911.348	0	911.019	5.19	911.523	13.576	912.574
17.756	912.839	21.332	913.384	25.28	914.02	28.768	915.265	32	916.51

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-36.223	.08	-12.483	.06	21.332	.08

```
Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -12.483  21.332           140.339 138.399 126.853             .1        .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.155

INPUT
Description: 39 m Upstream of 2nd Street Bridge
Station Elevation Data     num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -14.355 915.847 -10.776 913.969   -9.228 913.403   -6.02 912.683       0 911.652
   4.727 911.722  15.217 912.512    18.59 912.639  23.634 913.327  27.555 915.188
    30.5 915.532  34.711 917.929   39.315 919.403

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -14.355     .08   -9.228     .06   23.634     .08

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -9.228  23.634           25.946  23.816  15.636             .1        .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.131

INPUT
Description: 22 m Upstream of 2nd Street Bridge
Station Elevation Data     num=      12
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -23.789 919.138 -15.455 916.011 -15.177 915.081  -5.645 913.446  -2.694 912.829
       0 911.823   4.721 911.989   9.051 911.794   14.48 912.338  22.596 913.372
  36.749 918.277  48.812 919.492

Manning's n Values         num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -23.789     .08   -5.645     .06   22.596     .08

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -5.645  22.596           39.731  29.985  26.656             .1        .3
Skew Angle = 19

BRIDGE


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.110

INPUT
Description: Existing 2nd Street Bridge
Distance from Upstream XS =    15.48
Deck/Roadway Width        =   12.892
Weir Coefficient          =     1.44
Bridge Deck/Roadway Skew  =       19
Upstream  Deck/Roadway Coordinates
    num=       10
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
 -28.366 919.859      911  -22.54 919.924      911  -22.54 919.924  917.54
```

-7.345	920.01	917.626	-6.768	920.013	917.629	11.343	920.116	917.732
11.92	920.119	917.735	26.985	920.204	917.82	26.985	920.204	911
47.276	920.228	911						

Upstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.789	919.138	-15.455	916.011	-15.177	915.081	-5.645	913.446	-2.694	912.829
0	911.823	4.721	911.989	9.051	911.794	14.48	912.338	22.596	913.372
36.749	918.277	48.812	919.492						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.789	.08	-5.645	.06	22.596	.08

Bank Sta: Left Right Coeff Contr. Expan.
-5.645 22.596 .1 .3
Skew Angle = 19

Downstream Deck/Roadway Coordinates
num= 10

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-28.366	919.859	911	-19.135	919.904	911	-19.135	919.904	917.52
-4.618	919.986	917.602	-4.041	919.989	917.605	14.69	920.095	917.711
15.266	920.098	917.714	30.57	920.184	917.8	30.57	920.184	911
47.276	920.228	911						

Downstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.789	919.138	-15.455	916.011	-15.177	915.081	-5.645	913.446	-2.694	912.829
0	911.823	4.721	911.989	9.051	911.794	14.48	912.338	22.596	913.372
36.749	918.277	48.812	919.492						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.789	.08	-5.645	.06	22.596	.08

Bank Sta: Left Right Coeff Contr. Expan.
-5.645 22.596 .1 .3
Skew Angle = 19

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 2

Pier Data
Pier Station Upstream= -7.056 Downstream= -4.33
Upstream num= 2

Width	Elev	Width	Elev
.61	911	.61	917.629

Downstream num= 2

Width	Elev	Width	Elev
.61	911	.61	917.605

Pier Data
Pier Station Upstream= 11.632 Downstream= 14.978

Upstream num= 2

Width	Elev	Width	Elev
.61	911	.61	917.735

Downstream num= 2

Width	Elev	Width	Elev
.61	911	.61	917.714

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.54	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.52	E.G. Elev (m)	915.53	915.53
Q Total (m3/s)	49.27	W.S. Elev (m)	915.52	915.51
Q Bridge (m3/s)	49.27	Crit W.S. (m)	912.98	912.97
Q Weir (m3/s)		Max Chl Dpth (m)	3.72	3.72
Weir Sta Lft (m)		Vel Total (m/s)	0.48	0.47
Weir Sta Rgt (m)		Flow Area (m2)	103.59	103.89
Weir Submerg		Froude # Chl	0.08	0.09
Weir Max Depth (m)		Specif Force (m3)	154.18	153.90
Min El Weir Flow (m)	919.34	Hydr Depth (m)	2.52	2.42
Min El Prs (m)	917.82	W.P. Total (m)	52.72	54.93
Delta EG (m)	0.01	Conv. Total (m3/s)	2857.7	2676.9
Delta WS (m)	0.01	Top Width (m)	41.07	42.86
BR Open Area (m2)	196.74	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.48	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	5.73	6.28
Br Sel Method	Energy only	Power Total (N/m s)	-1138.97	-1138.97

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.65	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.64	E.G. Elev (m)	914.65	914.65
Q Total (m3/s)	22.90	W.S. Elev (m)	914.64	914.64
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.60	912.58
Q Weir (m3/s)		Max Chl Dpth (m)	2.85	2.84
Weir Sta Lft (m)		Vel Total (m/s)	0.34	0.34
Weir Sta Rgt (m)		Flow Area (m2)	68.31	68.10
Weir Submerg		Froude # Chl	0.08	0.08
Weir Max Depth (m)		Specif Force (m3)	77.29	77.24
Min El Weir Flow (m)	919.34	Hydr Depth (m)	1.81	1.81
Min El Prs (m)	917.82	W.P. Total (m)	45.39	45.68
Delta EG (m)	0.01	Conv. Total (m3/s)	1632.1	1562.1
Delta WS (m)	0.01	Top Width (m)	37.65	37.63
BR Open Area (m2)	196.74	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.34	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	2.91	3.14
Br Sel Method	Energy only	Power Total (N/m s)	-1138.97	-1138.97

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.101

INPUT
Description: Downstream face of 2nd Street Bridge (copied from 33.131)
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.789	919.138	-15.455	916.011	-15.177	915.081	-5.645	913.446	-2.694	912.829
0	911.823	4.721	911.989	9.051	911.794	14.48	912.338	22.596	913.372
36.749	918.277	48.812	919.492						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.789	.08	-5.645	.06	22.596	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-5.645	22.596	493.525	515.055 526.652	.1	.3

Skew Angle = 19

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.586

INPUT
Description: Upstream of Pedestrian Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.861	917.46	-38.131	915.82	-35.251	914.82	-31.254	914.32	-29.586	913.62
-27.757	913.1	-10.101	912.23	0	912.22	7.668	912.85	9.721	913.68
10.88	914.27	14.11	914.73	17.031	915.81	19.808	917.4		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.861	.08	-29.586	.06	9.721	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-29.586	9.721	4	4	4	.1 .3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 32.584

INPUT
Description: Riverside Park Footbridge
Distance from Upstream XS = .001
Deck/Roadway Width = 3.048
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 7

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-40.882	917.416	916.35	-38.132	917.416	916.35	-38.132	918.788	916.35
-10.402	919.398	916.96	17.031	918.788	916.35	17.031	917.416	916.35
19.781	917.416	916.35						

Upstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.861	917.46	-38.131	915.82	-35.251	914.82	-31.254	914.32	-29.586	913.62
-27.757	913.1	-10.101	912.23	0	912.22	7.668	912.85	9.721	913.68
10.88	914.27	14.11	914.73	17.031	915.81	19.808	917.4		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.861	.08	-29.586	.06	9.721	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-29.586	9.721	.1	.3

Downstream Deck/Roadway Coordinates
num= 7

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-40.882	917.416	916.35	-38.132	917.416	916.35	-38.132	918.788	916.35
-10.402	919.398	916.96	17.031	918.788	916.35	17.031	917.416	916.35
19.781	917.416	916.35						

Downstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.465	917.47	-37.67	915.84	-34.779	914.79	-30.751	914.37	-29.483	913.62

-27.757	913.1	-9.811	912.36	0	912.22	7.668	912.85	9.931	913.62
10.918	914.19	14.506	914.79	17.501	915.81	20.152	917.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.465	.08	-29.483	.06	9.931	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-29.483	9.931	.1	.3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.43	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.42	E.G. Elev (m)	915.43	915.43
Q Total (m3/s)	49.27	W.S. Elev (m)	915.42	915.42
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.10	913.15
Q Weir (m3/s)		Max Chl Dpth (m)	3.20	3.20
Weir Sta Lft (m)		Vel Total (m/s)	0.40	0.41
Weir Sta Rgt (m)		Flow Area (m2)	122.87	120.73
Weir Submerg		Froude # Chl	0.08	0.08
Weir Max Depth (m)		Specif Force (m3)	168.17	162.42
Min El Weir Flow (m)	917.39	Hydr Depth (m)	2.32	2.28
Min El Prs (m)	916.96	W.P. Total (m)	53.81	53.76
Delta EG (m)	0.00	Conv. Total (m3/s)	3818.9	3715.6
Delta WS (m)	0.00	Top Width (m)	52.96	52.87

BR Open Area (m2)	188.88	Frctn Loss (m)	0.00
0.00			
BR Open Vel (m/s)	0.41	C & E Loss (m)	0.00
0.00			
Coef of Q		Shear Total (N/m2)	3.73
3.87			
Br Sel Method	Energy only	Power Total (N/m s)	-1956.33
-1937.38			

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.57	Element	Inside BR US	Inside BR
DS				
W.S. US. (m)	914.57	E.G. Elev (m)	914.57	
914.57				
Q Total (m3/s)	22.90	W.S. Elev (m)	914.57	
914.57				
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.81	
912.88				
Q Weir (m3/s)		Max Chl Dpth (m)	2.35	
2.35				
Weir Sta Lft (m)		Vel Total (m/s)	0.29	
0.29				
Weir Sta Rgt (m)		Flow Area (m2)	80.05	
78.06				
Weir Submerg		Froude # Chl	0.07	
0.07				
Weir Max Depth (m)		Specif Force (m3)	80.78	
76.81				
Min El Weir Flow (m)	917.39	Hydr Depth (m)	1.73	
1.70				
Min El Prs (m)	916.96	W.P. Total (m)	46.83	
46.49				
Delta EG (m)	0.00	Conv. Total (m3/s)	2047.3	
1967.9				
Delta WS (m)	0.00	Top Width (m)	46.23	
45.84				
BR Open Area (m2)	188.88	Frctn Loss (m)	0.00	
0.00				
BR Open Vel (m/s)	0.29	C & E Loss (m)	0.00	
0.00				
Coef of Q		Shear Total (N/m2)	2.10	
2.23				
Br Sel Method	Energy only	Power Total (N/m s)	-1956.33	
-1937.38				

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.582

INPUT
Description: Downstream of Pedestrian Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.465	917.47	-37.67	915.84	-34.779	914.79	-30.751	914.37	-29.483	913.62
-27.757	913.1	-9.811	912.36	0	912.22	7.668	912.85	9.931	913.62

10.918 914.19 14.506 914.79 17.501 915.81 20.152 917.42

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.465	.08	-29.483	.06	9.931	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-29.483	9.931	85.305	92.817	98.174	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.490

INPUT
Description: South of 5th Street Detention Pond
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-55.851	916.667	-46.63	915.296	-39.07	914.384	-36.911	913.45	-32.455	912.768
-29.543	912.454	-19.193	912.327	-7.536	912.366	0	912.24	9.006	912.563
13.309	912.973	14.731	913.455	19.172	914.628	31.216	915.089	43	915.55

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-55.851	.08	-36.911	.06	14.731	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-36.911	14.731	96.592	113.278	118.871	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.377

INPUT
Description: South of Tennis Courts
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-60.966	918.832	-55.547	917.4	-52.899	917.287	-44.944	914.476	-41.41	913.413
-34.18	912.836	-22.125	912.438	-10.84	911.61	0	911.08	3.945	912.221
7.892	912.826	11.978	913.484	16.362	915.087	20.656	916.844	22.573	917.394

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-60.966	.08	-41.41	.06	11.978	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-41.41	11.978	38.466	36.285	33.342	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.341

INPUT
Description: 9.7 m Upstream of the Baker Avenue Bridge
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-39.073	917.813	-29.974	914.01	-19.81	912.947	-14.929	912.563	-8.725	912.034
0	911.534	6.015	911.548	12.101	911.727	23.627	913.99	28.552	916.504

```
Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -39.073     .08 -29.974     .06  23.627     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -29.974  23.627            21.193     9.7  15.476             .1       .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 32.331

INPUT
Description: Upstream Face of Baker Avenue Bridge
Station Elevation Data     num=       14
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -32.117 917.758 -20.334   917.8 -17.123 916.333 -15.253 916.112 -11.228   914.3
  -7.511 912.783  -4.079 912.097       0 911.936   6.184 912.255   8.808 912.969
  12.703     914  16.471 916.319  21.197     918  27.371 918.164

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -32.117     .08  -7.511     .06   8.808     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.    Expan.
        -7.511   8.808            13.605  12.718  13.556             .1       .3

BRIDGE


RIVER: Whitefish River
REACH: Whitefish City      RS: 32.325

INPUT
Description: Baker Avenue Bridge
Distance from Upstream XS =     .022
Deck/Roadway Width        =  12.695
Weir Coefficient          =   1.44
Upstream  Deck/Roadway Coordinates
    num=        4
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     -21  917.82 916.312 -15.253 917.892 916.312  16.471 918.099 916.519
      22     918     916

Upstream Bridge Cross Section Data
Station Elevation Data     num=       14
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -32.117 917.758 -20.334   917.8 -17.123 916.333 -15.253 916.112 -11.228   914.3
  -7.511 912.783  -4.079 912.097       0 911.936   6.184 912.255   8.808 912.969
  12.703     914  16.471 916.319  21.197     918  27.371 918.164

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -32.117     .08  -7.511     .06   8.808     .08

Bank Sta: Left   Right    Coeff Contr.    Expan.
        -7.511   8.808             .1       .3

Downstream  Deck/Roadway Coordinates
    num=        4
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
```

```
      -18  917.82   916.3 -16.044 917.898 916.318  15.157 918.054 916.474
       21  918.13     916

 Downstream Bridge Cross Section Data
 Station Elevation Data    num=      12
      Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
  -30.115 917.664 -17.918  917.82 -16.044 916.118  -11.08  914.05   -7.91 913.081
   -4.192 912.516       0 912.248   3.068  912.29   6.676 913.148   9.732   914.1
   15.157 916.274  20.359 918.086

 Manning's n Values        num=       3
      Sta   n Val     Sta   n Val     Sta   n Val
  -30.115     .08  -11.08     .06   9.732     .08

 Bank Sta: Left   Right    Coeff Contr.    Expan.
         -11.08   9.732             .1        .3

 Upstream Embankment side slope                =       0 horiz. to 1.0 vertical
 Downstream Embankment side slope              =       0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow =      .95
 Elevation at which weir flow begins           =
 Energy head used in spillway design           =
 Spillway height used in design                =
 Weir crest shape                              = Broad Crested

 Number of Bridge Coefficient Sets =  1

 Low Flow Methods and Data
       Energy
 Selected Low Flow Methods = Highest Energy Answer

 High Flow Method
       Energy Only

 Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

 BRIDGE OUTPUT  Profile #100-YEAR


   E.G. US. (m)              915.40    Element                Inside BR US  Inside BR
 DS
   W.S. US. (m)              915.37    E.G. Elev (m)               915.40
 915.39
   Q Total (m3/s)             49.27    W.S. Elev (m)               915.37
 915.35
   Q Bridge (m3/s)            49.27    Crit W.S. (m)               913.21
 913.61
   Q Weir (m3/s)                       Max Chl Dpth (m)              3.43
 3.10
   Weir Sta Lft (m)                    Vel Total (m/s)               0.72
 0.88
   Weir Sta Rgt (m)                    Flow Area (m2)               68.09
 55.70
   Weir Submerg                        Froude # Chl                  0.15
 0.19
   Weir Max Depth (m)                  Specif Force (m3)            99.55
 73.76
   Min El Weir Flow (m)      917.76    Hydr Depth (m)                2.39
```

2.06 Min El Prs (m)	916.52	W.P. Total (m)	29.75
27.98 Delta EG (m)	0.01	Conv. Total (m3/s)	2063.6
1595.5 Delta WS (m)	0.02	Top Width (m)	28.52
27.04 BR Open Area (m2)	86.71	Frctn Loss (m)	0.01
0.00 BR Open Vel (m/s)	0.88	C & E Loss (m)	0.00
0.00 Coef of Q		Shear Total (N/m2)	12.80
18.62 Br Sel Method	Energy only	Power Total (N/m s)	-1537.70
-1441.84			

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.55	Element	Inside BR US	Inside BR
DS W.S. US. (m)	914.54	E.G. Elev (m)	914.55	
914.55 Q Total (m3/s)	22.90	W.S. Elev (m)	914.54	
914.52 Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.81	
913.19 Q Weir (m3/s)		Max Chl Dpth (m)	2.60	
2.28 Weir Sta Lft (m)		Vel Total (m/s)	0.50	
0.65 Weir Sta Rgt (m)		Flow Area (m2)	45.78	
35.12 Weir Submerg		Froude # Chl	0.12	
0.16 Weir Max Depth (m)		Specif Force (m3)	49.87	
33.57 Min El Weir Flow (m)	917.76	Hydr Depth (m)	1.81	
1.53 Min El Prs (m)	916.52	W.P. Total (m)	26.15	
23.63 Delta EG (m)	0.01	Conv. Total (m3/s)	1178.9	
801.3 Delta WS (m)	0.01	Top Width (m)	25.34	
23.01 BR Open Area (m2)	86.71	Frctn Loss (m)	0.01	
0.00 BR Open Vel (m/s)	0.65	C & E Loss (m)	0.00	
0.00 Coef of Q		Shear Total (N/m2)	6.48	
11.91 Br Sel Method	Energy only	Power Total (N/m s)	-1537.70	
-1441.84				

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.318

INPUT
Description: Downstream Face of Baker Avenue Bridge
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-30.115	917.664	-17.918	917.82	-16.044	916.118	-11.08	914.05	-7.91	913.081
-4.192	912.516	0	912.248	3.068	912.29	6.676	913.148	9.732	914.1
15.157	916.274	20.359	918.086						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-30.115	.08	-11.08	.06	9.732	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-11.08	9.732	6.645	6.753	9.156	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.311

INPUT
Description: 6.7 m Downstream of the Baker Street Bridge
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-18.944	917.652	-12.03	914.01	-8.811	911.752	-4.21	911.147	-1.36	911.957
0	911.963	5.304	912.123	7.367	912.728	14.135	913.8	15.352	914.01
27.771	917.4								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-18.944	.08	-12.03	.06	15.352	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-12.03	15.352	71.378	48.8	34.305	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.262

INPUT
Description: 55 m Downstream of the Baker Avenue Bridge
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-31.214	918.657	-26.254	917.294	-21.342	916.737	-18.211	915.342	-15.746	914.045
-12.868	913.41	-10.16	912.897	-7.915	912.419	-6.23	911.796	0	911.733
5.985	912.604	14.884	912.578	22.376	912.8	25.178	913.417	28.52	913.966
34.12	915.538	35.639	915.689						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-31.214	.08	-12.868	.06	25.178	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-12.868	25.178	75.072	71.927	67.215	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.190

INPUT
Description: Southwest of the Central Ave. and 6th Street Intersection
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-34.893	917.401	-28.897	916.829	-22.917	914.689	-17.808	913.39	-14.945	912.677
-13.232	912.576	-10.808	912.343	-4.563	911.607	0	911.306	5.431	911.993
9.537	912.365	15.924	912.791	20.603	913.475	21.448	913.812	24.026	915.02
27.702	915.044	35	915.344	43	915.644				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-34.893	.08	-17.808	.06	20.603	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-17.808	20.603	53.338	45.112	28.737	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.145

INPUT
Description: Upstream of the new 7th Street Bridge
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-51.469	920.536	-34.983	916.888	-24.204	913.6	-17.152	912.832	-14.392	912.456
-7.806	911.91	0	911.583	7.553	911.995	17.804	912.328	24.968	912.715
29.571	913.348	34.956	912.481	41.73	912.165	48.42	913.362	51.056	915.217
55.569	915.766	65.834	915.014	71.893	916.112	78.106	916.395		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-51.469	.08	-24.204	.06	48.42	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-24.204	48.42	136.233	105.482	131.752	.1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-51.469	29.571	913.348	F
48.42	78.106	913.362	F

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.040

INPUT
Description: Downstream of the new 7th Street Bridge
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-24.979	917.618	-16.577	917.353	-11.973	915.311	-8.193	915.098	-4.396	913.45
0	911.437	2.888	911.539	8.469	911.929	10.867	912.248	12.621	912.849
13.296	913.279	14.143	914.169	25.509	914.128	37.091	914.143	49.732	913.862
62.305	913.54	77.906	913.374	89.076	913.415	102.251	913.167	113.73	913.225
130.227	913.46	134.679	915.064	141.093	916.368	141.952	920.11		

```
Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -24.979     .08  -4.396     .06 134.679     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.    Expan.
         -4.396 134.679           228.012 240.085 218.784              .1       .3
Ineffective Flow     num=        2
   Sta L   Sta R    Elev  Permanent
 -24.979  14.143 914.169          F
 134.679 141.952 915.064          F

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 31.800

INPUT
Description: Near Hotel Pool
Station Elevation Data     num=       14
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
  -54.78   919.55 -45.903  916.731 -39.245  916.359 -33.489  913.428 -32.348   913.11
 -23.534  912.079 -13.745  912.137       0  912.069   6.455  912.417   8.737  913.416
   9.915  913.394   12.183  914.267  16.556  917.569  18.194  917.772

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
  -54.78     .08 -33.489     .06   9.915     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.    Expan.
         -33.489   9.915            47.41  56.068  61.421              .1       .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 31.744

INPUT
Description: 59 m Upstream of N. Culvert under Spokane Avenue
Station Elevation Data     num=       15
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 -27.606  918.708 -21.301   916.65 -16.636  916.211 -13.566  914.459 -11.005  913.792
 -10.534  913.327  -6.758  912.501       0  911.956   5.746  912.054   8.938  912.481
  19.231  913.158   21.848  913.397    24.4  913.778  29.814  916.991  31.507  917.202

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -27.606     .08 -10.534     .06  21.848     .08

Bank Sta: Left   Right    Lengths: Left Channel   Right      Coeff Contr.    Expan.
         -10.534  21.848           30.463  33.958   44.91              .1       .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 31.710

INPUT
Description: 24 m Upstream of N. Culvert under Spokane Avenue
Station Elevation Data     num=       12
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-19.305	916.795	-18.101	916.106	-13.81	915.835	-8.011	913.371	-3.744	912.36
0	912.011	8.217	912.014	15.336	912.332	19.809	913.338	20.878	913.739
24.875	914.322	28.895	917.823						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-19.305	.08	-8.011	.06	19.809	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-8.011	19.809	20.119	21.179	22.681	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.689

INPUT
Description: Upstream Face of Culverts Under Spokane Avenue
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-16.036	916.5	-9.113	913.347	-6.893	912.631	0	912.42	7.383	912.431
13.908	912.821	15.532	913.382	17.658	914.455	24.273	914.6	29.145	914.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-16.036	.08	-9.113	.06	15.532	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.113	15.532	114.471	112.043	110.292	.1	.3

CULVERT

RIVER: Whitefish River
REACH: Whitefish City RS: 31.679

INPUT
Description: Upstream at Culverts under Spokane Avenue
Distance from Upstream XS = 47.496
Deck/Roadway Width = 19.934
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-20	923.5	911	0	923.5	911	30	923.5	911

Upstream Bridge Cross Section Data
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-16.036	916.5	-9.113	913.347	-6.893	912.631	0	912.42	7.383	912.431
13.908	912.821	15.532	913.382	17.658	914.455	24.273	914.6	29.145	914.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-16.036	.08	-9.113	.06	15.532	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.113	15.532	.1	.3

Downstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-25	923.5	911	0	923.5	911	30	923.5	911

Downstream Bridge Cross Section Data
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.367	917.528	-9.873	913.045	-7.489	912.265	-4.115	911.993	0	911.84
4.787	912.102	8.176	912.145	11.847	913.138	22.202	915.501	27.733	918

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.367	.08	-9.873	.06	11.847	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.873	11.847	.1	.3

Upstream Embankment side slope = 3.296 horiz. to 1.0 vertical
Downstream Embankment side slope = 3.126 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 3

Culvert Name	Shape	Rise	Span
NorthCulvert	Circular	4.572	

FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG

Culvert	Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
1	4.335	95.098	.024	.024	0	.9	

Upstream Elevation = 912.395
Centerline Station = -7.518
Downstream Elevation = 912.371
Centerline Station = -7.518

Culvert Name	Shape	Rise	Span
Cent Culvert	Circular	4.572	

FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG

Culvert	Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
1	9.445	95.098	.024	.024	0	.9	

Upstream Elevation = 912.523
Centerline Station = 0
Downstream Elevation = 912.274
Centerline Station = 0

Culvert Name	Shape	Rise	Span
SouthCulvert	Circular	4.572	

FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG

Culvert	Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
1	14.818	95.098	.024	.024	0	.9	

Upstream Elevation = 912.126
Centerline Station = 6.573
Downstream Elevation = 912.279
Centerline Station = 6.573

CULVERT OUTPUT Profile #100-YEAR Culv Group: NorthCulvert

Q Culv Group (m3/s)	16.06	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.63
Q Barrel (m3/s)	16.06	Culv Vel DS (m/s)	1.71
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.40
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.37
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.12
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.12
Delta EG (m)	0.36	Culv Entr Loss (m)	0.12
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.61	Weir Sta Lft (m)	
E.G. OC (m)	915.30	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	915.04	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)	4.57	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.54	Min El Weir Flow (m)	923.50

Note: The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height of the culvert.

CULVERT OUTPUT Profile #2-YEAR Culv Group: NorthCulvert

Q Culv Group (m3/s)	7.38	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.09
Q Barrel (m3/s)	7.38	Culv Vel DS (m/s)	1.12
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.40
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.37
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.05
Delta EG (m)	0.17	Culv Entr Loss (m)	0.05
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.82	Weir Sta Lft (m)	
E.G. OC (m)	914.48	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.37	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)	2.61	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.03	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #100-YEAR Culv Group: Cent Culvert

Q Culv Group (m3/s)	15.44	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.70
Q Barrel (m3/s)	15.44	Culv Vel DS (m/s)	1.57
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.52
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.27
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.11
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.10
Delta EG (m)	0.36	Culv Entr Loss (m)	0.13
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.68	Weir Sta Lft (m)	
E.G. OC (m)	915.28	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	

Culv WS Inlet (m)	915.00	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)	2.02	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.50	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #2-YEAR Culv Group: Cent Culvert

Q Culv Group (m3/s)	6.92	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.14
Q Barrel (m3/s)	6.92	Culv Vel DS (m/s)	0.99
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.52
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.27
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.04
Delta EG (m)	0.17	Culv Entr Loss (m)	0.06
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.90	Weir Sta Lft (m)	
E.G. OC (m)	914.47	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.34	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)	1.32	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.00	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #100-YEAR Culv Group: SouthCulvert

Q Culv Group (m3/s)	17.78	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.59
Q Barrel (m3/s)	17.78	Culv Vel DS (m/s)	1.82
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.13
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.28
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.11
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.14
Delta EG (m)	0.36	Culv Entr Loss (m)	0.12
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.48	Weir Sta Lft (m)	
E.G. OC (m)	915.31	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	915.07	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)		Weir Flow Area (m2)	
Culv Crt Depth (m)	1.62	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #2-YEAR Culv Group: SouthCulvert

Q Culv Group (m3/s)	8.60	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.07
Q Barrel (m3/s)	8.60	Culv Vel DS (m/s)	1.23
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.13
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.28
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.07
Delta EG (m)	0.17	Culv Entr Loss (m)	0.05
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.68	Weir Sta Lft (m)	
E.G. OC (m)	914.49	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.38	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)		Weir Flow Area (m2)	

Culv Crt Depth (m) 1.11 Min El Weir Flow (m) 923.50

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.576

INPUT
Description: Downstream Face of Culverts Under Spokane Avenue
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.367	917.528	-9.873	913.045	-7.489	912.265	-4.115	911.993	0	911.84
4.787	912.102	8.176	912.145	11.847	913.138	22.202	915.501	27.733	918

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.367	.08	-9.873	.06	11.847	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.873	11.847	12.94	17.232	19.788	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.559

INPUT
Description: 17 m Downstream of Culvert under Spokane Avenue
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-37.5	919.653	-31.838	917.86	-25.25	916.726	-20.927	914.517	15.744	913.138
-13.934	912.259	-9.968	912.335	-5.644	911.952	0	911.859	4.5	912.153
9.025	913.102	12.686	914.553	20.506	917.254	22.981	918.367		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-37.5	.08	-15.744	.06	9.025	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-15.744	9.025	28.885	28.896	31.31	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.530

INPUT
Description: 47 m Downstream of Culvert under Spokane Avenue
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-22.461	917.173	-19.397	916.603	-14.74	914.02	-12.608	913.603	-10.714	913.087
-9.591	912.563	-6.311	911.996	0	911.768	4.214	911.806	8.182	912.505
9.84	913.078	11.813	914.093	17.281	915.301	20.432	916.423	34.384	922.651
37.853	922.902								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-22.461	.08	-10.714	.06	9.84	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-10.714	9.84	68.247	69.304	67.842	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.461

INPUT
Description: 62 m Upstream of Columbia Avenue Bridge
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-29.852	918.87	-24.281	918.121	-10.065	914.157	-7.374	913.02	-4.378	912.424
0	911.592	4.446	911.629	8.758	912.644	12.112	913.018	19.82	915.813
24.946	917.242	38.64	922.8	42.331	922.898				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-29.852	.08	-7.374	.06	12.112	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-7.374	12.112	56.222	62.106	69.432	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.399

INPUT
Description: Upstream Face of Columbia Avenue Bridge
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-38.956	920.163	-34.901	919.687	-26.179	916.097	-18.181	913.155	-12.739	912.565
-11.354	912.371	-6.328	912.088	0	912.231	8.048	913.106	19.395	916.785
25.522	920.077	37.118	920.723						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-38.956	.08	-18.181	.06	8.048	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-18.181	8.048	12.192	11.204	12.083	.1	.3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 31.393

INPUT
Description: Columbia Avenue Bridge
Distance from Upstream XS = 1.3
Deck/Roadway Width = 9.903
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 8

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-39	920.218	912	-32.003	920.218	912	-32.003	920.218	918.49
-7.09	920.2	918.472	-5.566	920.2	918.472	22.615	920.178	918.45
22.615	920.178	912	26	920.178	912			

Upstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-38.956	920.163	-34.901	919.687	-26.179	916.097	-18.181	913.155	-12.739	912.565
-11.354	912.371	-6.328	912.088	0	912.231	8.048	913.106	19.395	916.785
25.522	920.077	37.118	920.723						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-38.956	.08	-18.181	.06	8.048	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-18.181	8.048	.1	.3

Downstream Deck/Roadway Coordinates
num= 8

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-39	920.188	912	-31.082	920.188	912	-31.082	920.188	918.46
-6.343	920.163	918.435	-4.819	920.163	918.435	23.266	920.144	918.416
23.266	920.144	912	26	920.144	912			

Downstream Bridge Cross Section Data
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-36.798	920.229	-31.272	920.189	-27.467	917.356	-23.436	916.002	-22.925	914.511
-15.6	913.067	-10.801	912.293	-5.657	912.401	0	912.195	10.83	912.683
12.844	913.007	18.248	914.735	23.289	917.37	23.348	920.144	28.441	919.96
32.056	920.582	36.436	920.837						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-36.798	.08	-15.6	.06	12.844	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-15.6	12.844	.1	.3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 1

Pier Data
Pier Station Upstream= -6.328 Downstream= -5.581
Upstream num= 2

Width	Elev	Width	Elev
1.524	912	1.524	918.472

Downstream num= 2

Width	Elev	Width	Elev
1.524	912	1.524	918.435

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	914.81	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.78	E.G. Elev (m)	914.81	914.80
Q Total (m3/s)	49.27	W.S. Elev (m)	914.78	914.77
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.25	913.17
Q Weir (m3/s)		Max Chl Dpth (m)	2.67	2.58
Weir Sta Lft (m)		Vel Total (m/s)	0.77	0.66
Weir Sta Rgt (m)		Flow Area (m2)	63.80	74.20
Weir Submerg		Froude # Chl	0.18	0.15
Weir Max Depth (m)		Specif Force (m3)	72.89	82.78
Min El Weir Flow (m)	920.11	Hydr Depth (m)	1.86	1.86
Min El Prs (m)	918.49	W.P. Total (m)	40.25	45.32
Delta EG (m)	0.01	Conv. Total (m3/s)	1490.7	1756.9
Delta WS (m)	0.01	Top Width (m)	34.27	39.81
BR Open Area (m2)	227.37	Frctn Loss (m)	0.01	0.00
BR Open Vel (m/s)	0.77	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	16.98	12.63
Br Sel Method	Energy only	Power Total (N/m s)	-1865.13	-1761.81

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.24	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.23	E.G. Elev (m)	914.24	914.23
Q Total (m3/s)	22.90	W.S. Elev (m)	914.23	914.22
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.91	912.87
Q Weir (m3/s)		Max Chl Dpth (m)	2.12	2.03
Weir Sta Lft (m)		Vel Total (m/s)	0.50	0.43

Weir Sta Rgt (m)		Flow Area (m2)	45.77
52.95			
Weir Submerg		Froude # Chl	0.13
0.11			
Weir Max Depth (m)		Specif Force (m3)	39.91
45.38			
Min El Weir Flow (m)	920.11	Hydr Depth (m)	1.47
1.45			
Min El Prs (m)	918.49	W.P. Total (m)	35.75
40.68			
Delta EG (m)	0.01	Conv. Total (m3/s)	933.6
1098.5			
Delta WS (m)	0.00	Top Width (m)	31.07
36.59			
BR Open Area (m2)	227.37	Frctn Loss (m)	0.01
0.00			
BR Open Vel (m/s)	0.50	C & E Loss (m)	0.00
0.00			
Coef of Q		Shear Total (N/m2)	7.55
5.55			
Br Sel Method	Energy only	Power Total (N/m s)	-1865.13
-1761.81			

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.388

INPUT
Description: Downstream Face of Columbia Avenue Bridge
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-36.798	920.229	-31.272	920.189	-27.467	917.356	-23.436	916.002	-22.925	914.511
-15.6	913.067	-10.801	912.293	-5.657	912.401	0	912.195	10.83	912.683
12.844	913.007	18.248	914.735	23.289	917.37	23.348	920.144	28.441	919.96
32.056	920.582	36.436	920.837						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-36.798	.08	-15.6	.06	12.844	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-15.6	12.844	17.995	14.752	11.664	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.373

INPUT
Description: 15 m Downstream of the Columbia Ave. Bridge
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-18.111	915.69	-11.714	915.38	-7.916	912.8	-3.647	912.26	0	912.27
5.27	912.44	11.356	912.77	18.171	914.4	23.601	917.65		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-18.111	.08	-7.916	.06	11.356	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-7.916	11.356	20.012	20.377	27.386	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.353

INPUT
Description: 35 m Downstream of Columbia Ave. Bridge
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-24.182	916.34	-19.958	915.02	-15.919	912.69	-13.645	912.08	-9.925	911.9
-5.188	911.84	0	911.76	6.541	911.72	8.414	912.26	13.521	911.87
16.254	912.79	22.897	914.4	28.383	917.29				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-24.182	.08	-15.919	.06	16.254	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-15.919	16.254	42.287	41.107	41.181	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.312

INPUT
Description: 76 m Downstream of Columbia Avenue Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.997	917.694	-23.743	917.179	-17.424	913.598	-13.986	913.028	-13.47	912.501
-10.692	910.915	-4.89	908.906	0	908.524	9.086	910.211	17.925	912.269
23.944	912.971	27.838	914.976	37.507	918.038	40.695	918.824		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.997	.08	-13.986	.06	23.944	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right		Coeff Contr.	Expan.
-13.986	23.944	182.801	151.975	105.156	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.160

INPUT
Description: 228 m Downstream of Columbia Avenue Bridge
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-21.387	914.759	-14.194	914.356	-9.883	913.027	-6.03	912.151	0	912.071
9.494	912.105	18.166	912.404	21.988	913.022	26.652	917.034		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-21.387	.08	-9.883	.06	21.988	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.883	21.988	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:Whitefish River

Reach	River Sta.	n1	n2	n3
Whitefish City	34.304	.08	.06	.08
Whitefish City	33.98	.08	.06	.08
Whitefish City	33.976	Bridge		
Whitefish City	33.972	.08	.06	.08
Whitefish City	33.639	.08	.06	.08
Whitefish City	33.408	.08	.06	.08
Whitefish City	33.293	.08	.06	.08
Whitefish City	33.155	.08	.06	.08
Whitefish City	33.131	.08	.06	.08
Whitefish City	33.110	Bridge		
Whitefish City	33.101	.08	.06	.08
Whitefish City	32.586	.08	.06	.08
Whitefish City	32.584	Bridge		
Whitefish City	32.582	.08	.06	.08
Whitefish City	32.490	.08	.06	.08
Whitefish City	32.377	.08	.06	.08
Whitefish City	32.341	.08	.06	.08
Whitefish City	32.331	.08	.06	.08
Whitefish City	32.325	Bridge		
Whitefish City	32.318	.08	.06	.08
Whitefish City	32.311	.08	.06	.08
Whitefish City	32.262	.08	.06	.08
Whitefish City	32.190	.08	.06	.08
Whitefish City	32.145	.08	.06	.08
Whitefish City	32.040	.08	.06	.08
Whitefish City	31.800	.08	.06	.08
Whitefish City	31.744	.08	.06	.08
Whitefish City	31.710	.08	.06	.08
Whitefish City	31.689	.08	.06	.08
Whitefish City	31.679	Culvert		
Whitefish City	31.576	.08	.06	.08
Whitefish City	31.559	.08	.06	.08
Whitefish City	31.530	.08	.06	.08
Whitefish City	31.461	.08	.06	.08
Whitefish City	31.399	.08	.06	.08
Whitefish City	31.393	Bridge		
Whitefish City	31.388	.08	.06	.08
Whitefish City	31.373	.08	.06	.08
Whitefish City	31.353	.08	.06	.08
Whitefish City	31.312	.08	.06	.08
Whitefish City	31.160	.08	.06	.08

SUMMARY OF REACH LENGTHS

River: Whitefish River

Reach	River Sta.	Left	Channel	Right
Whitefish City	34.304	337.355	325.924	331.97

Whitefish City	33.98	8.002	8.002	8.002
Whitefish City	33.976	Bridge		
Whitefish City	33.972	328.925	329.729	343.158
Whitefish City	33.639	184.125	230.908	267.49
Whitefish City	33.408	133.292	115.036	97.73
Whitefish City	33.293	140.339	138.399	126.853
Whitefish City	33.155	25.946	23.816	15.636
Whitefish City	33.131	39.731	29.985	26.656
Whitefish City	33.110	Bridge		
Whitefish City	33.101	493.525	515.055	526.652
Whitefish City	32.586	4	4	4
Whitefish City	32.584	Bridge		
Whitefish City	32.582	85.305	92.817	98.174
Whitefish City	32.490	96.592	113.278	118.871
Whitefish City	32.377	38.466	36.285	33.342
Whitefish City	32.341	21.193	9.7	15.476
Whitefish City	32.331	13.605	12.718	13.556
Whitefish City	32.325	Bridge		
Whitefish City	32.318	6.645	6.753	9.156
Whitefish City	32.311	71.378	48.8	34.305
Whitefish City	32.262	75.072	71.927	67.215
Whitefish City	32.190	53.338	45.112	28.737
Whitefish City	32.145	136.233	105.482	131.752
Whitefish City	32.040	228.012	240.085	218.784
Whitefish City	31.800	47.41	56.068	61.421
Whitefish City	31.744	30.463	33.958	44.91
Whitefish City	31.710	20.119	21.179	22.681
Whitefish City	31.689	114.471	112.043	110.292
Whitefish City	31.679	Culvert		
Whitefish City	31.576	12.94	17.232	19.788
Whitefish City	31.559	28.885	28.896	31.31
Whitefish City	31.530	68.247	69.304	67.842
Whitefish City	31.461	56.222	62.106	69.432
Whitefish City	31.399	12.192	11.204	12.083
Whitefish City	31.393	Bridge		
Whitefish City	31.388	17.995	14.752	11.664
Whitefish City	31.373	20.012	20.377	27.386
Whitefish City	31.353	42.287	41.107	41.181
Whitefish City	31.312	182.801	151.975	105.156
Whitefish City	31.160	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Whitefish River

Reach	River Sta.	Contr.	Expan.
Whitefish City	34.304	.1	.3
Whitefish City	33.98	.1	.3
Whitefish City	33.976	Bridge	
Whitefish City	33.972	.1	.3
Whitefish City	33.639	.1	.3
Whitefish City	33.408	.1	.3
Whitefish City	33.293	.1	.3
Whitefish City	33.155	.1	.3
Whitefish City	33.131	.1	.3
Whitefish City	33.110	Bridge	
Whitefish City	33.101	.1	.3
Whitefish City	32.586	.1	.3
Whitefish City	32.584	Bridge	

Whitefish City	32.582		.1	.3
Whitefish City	32.490		.1	.3
Whitefish City	32.377		.1	.3
Whitefish City	32.341		.1	.3
Whitefish City	32.331		.1	.3
Whitefish City	32.325	Bridge		
Whitefish City	32.318		.1	.3
Whitefish City	32.311		.1	.3
Whitefish City	32.262		.1	.3
Whitefish City	32.190		.1	.3
Whitefish City	32.145		.1	.3
Whitefish City	32.040		.1	.3
Whitefish City	31.800		.1	.3
Whitefish City	31.744		.1	.3
Whitefish City	31.710		.1	.3
Whitefish City	31.689		.1	.3
Whitefish City	31.679	Culvert		
Whitefish City	31.576		.1	.3
Whitefish City	31.559		.1	.3
Whitefish City	31.530		.1	.3
Whitefish City	31.461		.1	.3
Whitefish City	31.399		.1	.3
Whitefish City	31.393	Bridge		
Whitefish City	31.388		.1	.3
Whitefish City	31.373		.1	.3
Whitefish City	31.353		.1	.3
Whitefish City	31.312		.1	.3
Whitefish City	31.160		.1	.3

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : Plan 03

River: Whitefish River Reach: Whitefish City RS: 34.304 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 34.304 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.972 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.972 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.639 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.639 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.582 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

River: Whitefish River Reach: Whitefish City RS: 32.341 Profile: 100-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.341 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.325 Profile: 2-YEAR Upstream
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.318 Profile: 100-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.318 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.190 Profile: 100-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.190 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.145 Profile: 100-YEAR
  Warning:Divided flow computed for this cross-section.
River: Whitefish River Reach: Whitefish City RS: 32.145 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
  Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 32.040 Profile: 100-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
  Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 32.040 Profile: 2-YEAR
  Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 31.800 Profile: 100-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.800 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.710 Profile: 2-YEAR
  Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
  This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.679 Profile: 100-YEAR
  Culv: NorthCulvert
  Note: The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height
  of the culvert.

River: Whitefish River Reach: Whitefish City RS: 31.388 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.388 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.373 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.373 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.353 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.353 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.312 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.312 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

APPENDIX D
HEC-RAS Output (Proposed 42-meter Bridge)

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX         XXXX        XX       XXXX
X     X  X        X    X       X   X      X  X     X
X     X  X        X            X   X     X    X    X
XXXXXXX  XXXX     X       XXX  XXXX      XXXXXX    XXXX
X     X  X        X            X  X      X    X        X
X     X  X        X    X       X   X     X    X        X
X     X  XXXXXX    XXXX        X    X    X    X   XXXXX
```

PROJECT DATA
Project Title: Whitefish West 42 m Bridge
Project File : WfishWest42m.prj
Run Date and Time: 12/23/2011 8:20:10 AM

Project in SI units

Project Description:
Whitefish River, Whitefish, MT, Kevin Slovarp, WGM Group, Proj. 030606, Dec. 21, 2005

PLAN DATA

Plan Title: 42 m Bridge & Adjusted FIS Elevation
Plan File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.p04

Geometry Title: WR - EC w/ 42m bridge at 2nd w/ path
Geometry File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.g20

Flow Title : Whitefish River - Adjusted FIS Elevation
Flow File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.f03

Plan Summary Information:

Number of:	Cross Sections	= 35	Multiple Openings	=	0
	Culverts	= 1	Inline Structures	=	0
	Bridges	= 5	Lateral Structures	=	0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Whitefish River - Adjusted FIS Elevation
Flow File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.f03

Flow Data (m3/s)

River	Reach	RS	10-YEAR	50-YEAR	100-YEAR	500-YEAR
Whitefish River	Whitefish City	34.304	36.246	45.732	49.271	59.182
		22.9				

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Whitefish River	Whitefish City	10-YEAR		
Known WS = 914.4				
Whitefish River	Whitefish City	50-YEAR		
Known WS = 914.64				
Whitefish River	Whitefish City	100-YEAR		
Known WS = 914.72				
Whitefish River	Whitefish City	500-YEAR		
Known WS = 914.94				
Whitefish River	Whitefish City	2-YEAR		
Known WS = 914.2				

GEOMETRY DATA

Geometry Title: WR - EC w/ 42m bridge at 2nd w/ path
Geometry File : w:\Projects\030413\Hydraulics\Bridge Permitting\WfishWest42m.g20

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 34.304

INPUT
Description: 61.089 meters downstream of Whitefish Lake
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-46.198	919.091	-44.313	918.982	-34.124	917.458	-14.452	915.418	-11.643	914.252
-11.176	913.47	-4.99	912.923	0	912.375	10.047	912.48	14.428	912.863
22.288	912.989	26.918	912.631	31.496	912.45	37.748	913.12	41.343	913.433
51.005	914.407	53.387	915.887	66.911	916.266				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

-46.198	.08	-11.176	.06	41.343	.08				

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-11.176	41.343	337.355	325.924	331.97	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.98

INPUT
Description: Upstream Face of Burlington Northern Railroad Bridge
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.549	22.391	8.002	8.002	8.002	.1	.3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 33.976

INPUT
Description: Burlington Northern Rail Road Bridge
Distance from Upstream XS = .001
Deck/Roadway Width = 8
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 14

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-42.654	925.82	912	-42.654	925.82	923.19	-25.309	925.84	923.21
-22.915	925.84	923.21	-13.216	925.84	923.21	-10.878	925.84	923.21
12.335	925.85	923.21	14.594	925.85	923.21	24.462	925.85	923.22
26.836	925.85	923.22	43.784	925.86	923.23	46.515	925.86	923.23
58.734	925.87	923.24	58.734	925.87	912			

Upstream Bridge Cross Section Data
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.549	22.391	.1	.3

Downstream Deck/Roadway Coordinates
num= 14

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord

-42.954	925.82	912	-42.954	925.82	923.19	-25.683	925.84	923.21
-23.289	925.84	923.21	-13.613	925.84	923.21	-11.275	925.84	923.21
11.96	925.85	923.21	14.219	925.85	923.21	24.159	925.85	923.22
26.533	925.85	923.22	43.398	925.86	923.23	46.129	925.86	923.23
58.411	925.87	923.24	558.411	925.87	912			

Downstream Bridge Cross Section Data
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.549	22.391	.1	.3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 5

Pier Data
Pier Station Upstream= -24.112 Downstream= -24.486

Upstream num= 2			
Width	Elev	Width	Elev
2.394	912	2.394	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.394	912	2.394	923.21

Pier Data
Pier Station Upstream= -12.047 Downstream= -12.444

Upstream num= 2			
Width	Elev	Width	Elev
2.338	912	2.338	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.338	912	2.338	923.21

Pier Data
Pier Station Upstream= 13.465 Downstream= 13.09

Upstream num= 2			
Width	Elev	Width	Elev
2.259	912	2.259	923.21
Downstream num= 2			
Width	Elev	Width	Elev
2.259	912	2.259	923.21

Pier Data
Pier Station Upstream= 25.649 Downstream= 25.346

Upstream num= 2			
Width	Elev	Width	Elev
2.374	912	2.374	923.22
Downstream num= 2			

Width	Elev	Width	Elev
2.374	912	2.374	923.22

Pier Data
Pier Station Upstream= 45.15 Downstream= 44.764
Upstream num= 2

Width	Elev	Width	Elev
2.731	912	2.731	923.23

Downstream num= 2

Width	Elev	Width	Elev
2.731	912	2.731	923.23

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.63	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.62	E.G. Elev (m)	915.63	915.63
Q Total (m3/s)	49.27	W.S. Elev (m)	915.62	915.61
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.39	913.39
Q Weir (m3/s)		Max Chl Dpth (m)	3.55	3.55
Weir Sta Lft (m)		Vel Total (m/s)	0.45	0.45
Weir Sta Rgt (m)		Flow Area (m2)	109.09	109.00
Weir Submerg		Froude # Chl	0.10	0.10
Weir Max Depth (m)		Specif Force (m3)	145.07	144.83
Min El Weir Flow (m)	921.17	Hydr Depth (m)	2.10	2.10
Min El Prs (m)	923.24	W.P. Total (m)	60.65	62.57
Delta EG (m)	0.00	Conv. Total (m3/s)	2997.6	2964.9
Delta WS (m)	0.00	Top Width (m)	52.04	52.01
BR Open Area (m2)	671.88	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.45	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	4.77	4.72

Br Sel Method	Energy only	Power Total (N/m s)	-2065.36

-2065.36

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.71	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.71	E.G. Elev (m)	914.71	914.71
Q Total (m3/s)	22.90	W.S. Elev (m)	914.71	914.71
Q Bridge (m3/s)	22.90	Crit W.S. (m)	913.03	913.02
Q Weir (m3/s)		Max Chl Dpth (m)	2.65	2.64
Weir Sta Lft (m)		Vel Total (m/s)	0.35	0.35
Weir Sta Rgt (m)		Flow Area (m2)	66.37	66.33
Weir Submerg		Froude # Chl	0.08	0.09
Weir Max Depth (m)		Specif Force (m3)	64.44	64.30
Min El Weir Flow (m)	921.17	Hydr Depth (m)	1.58	1.58
Min El Prs (m)	923.24	W.P. Total (m)	46.83	47.84
Delta EG (m)	0.00	Conv. Total (m3/s)	1545.6	1534.1
Delta WS (m)	0.00	Top Width (m)	42.02	42.00
BR Open Area (m2)	671.88	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.35	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	3.05	3.03
Br Sel Method	Energy only	Power Total (N/m s)	-2065.36	-2065.36

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.972

INPUT
Description: Downstream Face of Burlington Northern Railroad Bridge
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.138	921.235	-38.712	919.588	-29.359	919.647	-24.577	916.559	-12.301	913.809
-9.549	913.424	-5.397	912.826	0	912.061	7.379	912.506	13.266	913.071
21.014	913.158	22.391	913.409	25.142	913.561	44.811	916.554	59.726	921.949

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.138	.08	-9.549	.06	22.391	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.549	22.391	328.925	329.729 343.158	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.639

INPUT
Description: Lumber Yard
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-58.671	920.165	-54.054	920.242	-43.575	917.083	-36.738	913.774	-30.97	913.338
-22.859	912.537	-22.751	913.269	-18.982	911.446	-10.811	911.946	0	911.877
7.31	912.005	18.367	913.008	19.85	913.374	35.311	915.121	48.952	922.805
55.02	923.624								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-58.671	.08	-30.97	.06	19.85	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-30.97	19.85	184.125	230.908 267.49	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.408

INPUT
Description: Section at Arc-Shaped Railroad Building
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-43.511	916.86	-37.556	915.504	-27.515	914.71	-23.336	913.901	-21.536	913.492
-15.163	912.688	-7.614	911.912	0	911.652	6.52	912.67	11.26	913.53
18.797	914.586	21.925	915.493	25.865	915.859	28.978	917.106	31.688	917.337

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-43.511	.08	-21.536	.06	11.26	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-21.536	11.26	133.292	115.036 97.73	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.293

INPUT
Description: SW of Railroad Holding Ponds
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-36.223	919.226	-25.107	916.178	-20.991	915.858	-16.031	914.04	-12.483	913.418
-6.87	912.622	-5.075	911.348	0	911.019	5.19	911.523	13.576	912.574
17.756	912.839	21.332	913.384	25.28	914.02	28.768	915.265	32	916.51

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-36.223	.08	-12.483	.06	21.332	.08

```
Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -12.483  21.332           140.339 138.399 126.853              .1        .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.155

INPUT
Description: 39 m Upstream of 2nd Street Bridge
Station Elevation Data    num=      13
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -14.355 915.847 -10.776 913.969  -9.228 913.403   -6.02 912.683        0 911.652
   4.727 911.722  15.217 912.512   18.59 912.639  23.634 913.327  27.555 915.188
    30.5 915.532  34.711 917.929  39.315 919.403

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -14.355     .08   -9.228     .06   23.634     .08

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -9.228  23.634            25.946  23.816  15.636              .1        .3

CROSS SECTION


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.131

INPUT
Description: 22 m Upstream of 2nd Street Bridge
Station Elevation Data    num=      12
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -23.789 919.138 -15.455 916.011 -15.177 915.081  -5.645 913.446  -2.694 912.829
       0 911.823   4.721 911.989   9.051 911.794   14.48 912.338  22.596 913.372
  36.749 918.277  48.812 919.492

Manning's n Values        num=       3
     Sta   n Val      Sta   n Val      Sta   n Val
 -23.789     .08   -5.645     .06   22.596     .08

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       -5.645  22.596            39.731  29.985  26.656              .1        .3
Skew Angle = 19

BRIDGE


RIVER: Whitefish River
REACH: Whitefish City      RS: 33.110

INPUT
Description: 2nd Street 42 meter Bridge
Distance from Upstream XS =    14.67
Deck/Roadway Width        =    14.86
Weir Coefficient          =     1.44
Bridge Deck/Roadway Skew  =       19
Upstream  Deck/Roadway Coordinates
    num=        6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
     -25 919.177     911  -13.44 919.177     911  -13.44 919.177 917.283
```

```
  25.138  919.67 917.453  25.138  919.67     911      49  919.67     911

 Upstream Bridge Cross Section Data
 Station Elevation Data    num=      12
      Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -23.789 919.138 -15.455 916.011 -15.177 915.081  -5.645 913.446  -2.694 912.829
       0 911.823   4.721 911.989   9.051 911.794   14.48 912.338  22.596 913.372
  36.749 918.277  48.812 919.492

 Manning's n Values        num=       3
      Sta   n Val     Sta   n Val     Sta   n Val
 -23.789     .08  -5.645     .06  22.596     .08

 Bank Sta: Left   Right    Coeff Contr.    Expan.
         -5.645  22.596             .1       .3
 Skew Angle = 19

 Downstream  Deck/Roadway Coordinates
     num=       6
      Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
      -25 919.177     911  -13.44 919.177     911  -13.44 919.177 917.283
  25.138  919.67 917.453  25.138  919.67     911      49  919.67     911

 Downstream Bridge Cross Section Data
 Station Elevation Data    num=      12
      Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 -23.789 919.138 -15.455 916.011 -15.177 915.081  -5.645 913.446  -2.694 912.829
       0 911.823   4.721 911.989   9.051 911.794   14.48 912.338  22.596 913.372
  36.749 918.277  48.812 919.492

 Manning's n Values        num=       3
      Sta   n Val     Sta   n Val     Sta   n Val
 -23.789     .08  -5.645     .06  22.596     .08

 Bank Sta: Left   Right    Coeff Contr.    Expan.
         -5.645  22.596             .1       .3
 Skew Angle = 19

 Upstream Embankment side slope                =       0 horiz. to 1.0 vertical
 Downstream Embankment side slope              =       0 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow =     .95
 Elevation at which weir flow begins           =
 Energy head used in spillway design           =
 Spillway height used in design                =
 Weir crest shape                              = Broad Crested

 Number of Abutments =  2

 Abutment Data
 Upstream     num=       3
      Sta    Elev     Sta    Elev     Sta    Elev
   -13.44 914.845 -10.319   914.8  -6.206   911.9
 Downstream     num=       3
      Sta    Elev     Sta    Elev     Sta    Elev
   -13.44 914.845 -10.319   914.8  -6.206   911.9

 Abutment Data
 Upstream     num=       2
      Sta    Elev     Sta    Elev
   19.532   911.9  25.138 915.853
 Downstream     num=       2
      Sta    Elev     Sta    Elev
   19.532   911.9  25.138 915.853
```

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth
inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.53	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.52	E.G. Elev (m)	915.53	915.53
Q Total (m3/s)	49.27	W.S. Elev (m)	915.52	915.51
Q Bridge (m3/s)	49.27	Crit W.S. (m)	912.97	912.97
Q Weir (m3/s)		Max Chl Dpth (m)	3.72	3.72
Weir Sta Lft (m)		Vel Total (m/s)	0.50	0.50
Weir Sta Rgt (m)		Flow Area (m2)	99.49	99.35
Weir Submerg		Froude # Chl	0.10	0.10
Weir Max Depth (m)		Specif Force (m3)	152.59	152.25
Min El Weir Flow (m)	919.18	Hydr Depth (m)	2.61	2.61
Min El Prs (m)	917.45	W.P. Total (m)	40.12	40.11
Delta EG (m)	0.01	Conv. Total (m3/s)	3245.4	3239.0
Delta WS (m)	0.01	Top Width (m)	38.10	38.10
BR Open Area (m2)	170.81	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.50	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	5.60	5.62
Br Sel Method	Energy only	Power Total (N/m s)	-1138.97	-1138.97

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.65	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.64	E.G. Elev (m)	914.65	

Q Total (m3/s)	22.90	W.S. Elev (m)	914.64
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.58
Q Weir (m3/s)		Max Chl Dpth (m)	2.85
Weir Sta Lft (m)		Vel Total (m/s)	0.34
Weir Sta Rgt (m)		Flow Area (m2)	67.23
Weir Submerg		Froude # Chl	0.08
Weir Max Depth (m)		Specif Force (m3)	78.05
Min El Weir Flow (m)	919.18	Hydr Depth (m)	2.01
Min El Prs (m)	917.45	W.P. Total (m)	34.53
Delta EG (m)	0.00	Conv. Total (m3/s)	1829.7
Delta WS (m)	0.00	Top Width (m)	33.51
BR Open Area (m2)	170.81	Frctn Loss (m)	0.00
BR Open Vel (m/s)	0.34	C & E Loss (m)	0.00
Coef of Q		Shear Total (N/m2)	2.99
Br Sel Method	Energy only	Power Total (N/m s)	-1138.97

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 33.101

INPUT
Description: Downstream face of 2nd Street Bridge (copied from 33.131)
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.789	919.138	-15.455	916.011	-15.177	915.081	-5.645	913.446	-2.694	912.829
0	911.823	4.721	911.989	9.051	911.794	14.48	912.338	22.596	913.372
36.749	918.277	48.812	919.492						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.789	.08	-5.645	.06	22.596	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-5.645	22.596	493.525	515.055 526.652	.1	.3

Skew Angle = 19

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.586

INPUT

Description: Upstream of Pedestrian Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.861	917.46	-38.131	915.82	-35.251	914.82	-31.254	914.32	-29.586	913.62
-27.757	913.1	-10.101	912.23	0	912.22	7.668	912.85	9.721	913.68
10.88	914.27	14.11	914.73	17.031	915.81	19.808	917.4		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.861	.08	-29.586	.06	9.721	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-29.586	9.721	4	4	.1	.3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 32.584

INPUT
Description: Riverside Park Footbridge
Distance from Upstream XS = .001
Deck/Roadway Width = 3.048
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 7

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-40.882	917.416	916.35	-38.132	917.416	916.35	-38.132	918.788	916.35
-10.402	919.398	916.96	17.031	918.788	916.35	17.031	917.416	916.35
19.781	917.416	916.35						

Upstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.861	917.46	-38.131	915.82	-35.251	914.82	-31.254	914.32	-29.586	913.62
-27.757	913.1	-10.101	912.23	0	912.22	7.668	912.85	9.721	913.68
10.88	914.27	14.11	914.73	17.031	915.81	19.808	917.4		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.861	.08	-29.586	.06	9.721	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-29.586	9.721	.1	.3

Downstream Deck/Roadway Coordinates
num= 7

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-40.882	917.416	916.35	-38.132	917.416	916.35	-38.132	918.788	916.35
-10.402	919.398	916.96	17.031	918.788	916.35	17.031	917.416	916.35
19.781	917.416	916.35						

Downstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.465	917.47	-37.67	915.84	-34.779	914.79	-30.751	914.37	-29.483	913.62
-27.757	913.1	-9.811	912.36	0	912.22	7.668	912.85	9.931	913.62
10.918	914.19	14.506	914.79	17.501	915.81	20.152	917.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.465	.08	-29.483	.06	9.931	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-29.483	9.931	.1	.3

Upstream Embankment side slope = 0 horiz. to 1.0 vertical
Downstream Embankment side slope = 0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	915.43	Element	Inside BR US	Inside BR DS
W.S. US. (m)	915.42	E.G. Elev (m)	915.43	915.43
Q Total (m3/s)	49.27	W.S. Elev (m)	915.42	915.42
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.10	913.15
Q Weir (m3/s)		Max Chl Dpth (m)	3.20	3.20
Weir Sta Lft (m)		Vel Total (m/s)	0.40	0.41
Weir Sta Rgt (m)		Flow Area (m2)	122.87	120.73
Weir Submerg		Froude # Chl	0.08	0.08
Weir Max Depth (m)		Specif Force (m3)	168.17	162.42
Min El Weir Flow (m)	917.39	Hydr Depth (m)	2.32	2.28
Min El Prs (m)	916.96	W.P. Total (m)	53.81	53.76
Delta EG (m)	0.00	Conv. Total (m3/s)	3818.9	3715.6
Delta WS (m)	0.00	Top Width (m)	52.96	52.87
BR Open Area (m2)	188.88	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.41	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	3.73	3.87

Br Sel Method	Energy only	Power Total (N/m s)	-1956.33
-1937.38			

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.57	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.57	E.G. Elev (m)	914.57	914.57
Q Total (m3/s)	22.90	W.S. Elev (m)	914.57	914.57
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.81	912.88
Q Weir (m3/s)		Max Chl Dpth (m)	2.35	2.35
Weir Sta Lft (m)		Vel Total (m/s)	0.29	0.29
Weir Sta Rgt (m)		Flow Area (m2)	80.05	78.06
Weir Submerg		Froude # Chl	0.07	0.07
Weir Max Depth (m)		Specif Force (m3)	80.78	76.81
Min El Weir Flow (m)	917.39	Hydr Depth (m)	1.73	1.70
Min El Prs (m)	916.96	W.P. Total (m)	46.83	46.49
Delta EG (m)	0.00	Conv. Total (m3/s)	2047.3	1967.9
Delta WS (m)	0.00	Top Width (m)	46.23	45.84
BR Open Area (m2)	188.88	Frctn Loss (m)	0.00	0.00
BR Open Vel (m/s)	0.29	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	2.10	2.23
Br Sel Method	Energy only	Power Total (N/m s)	-1956.33	-1937.38

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.582

INPUT
Description: Downstream of Pedestrian Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-40.465	917.47	-37.67	915.84	-34.779	914.79	-30.751	914.37	-29.483	913.62
-27.757	913.1	-9.811	912.36	0	912.22	7.668	912.85	9.931	913.62
10.918	914.19	14.506	914.79	17.501	915.81	20.152	917.42		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-40.465	.08	-29.483	.06	9.931	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-29.483	9.931	85.305	92.817	98.174	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.490

INPUT
Description: South of 5th Street Detention Pond
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-55.851	916.667	-46.63	915.296	-39.07	914.384	-36.911	913.45	-32.455	912.768
-29.543	912.454	-19.193	912.327	-7.536	912.366	0	912.24	9.006	912.563
13.309	912.973	14.731	913.455	19.172	914.628	31.216	915.089	43	915.55

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-55.851	.08	-36.911	.06	14.731	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-36.911	14.731	96.592	113.278	118.871	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.377

INPUT
Description: South of Tennis Courts
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-60.966	918.832	-55.547	917.4	-52.899	917.287	-44.944	914.476	-41.41	913.413
-34.18	912.836	-22.125	912.438	-10.84	911.61	0	911.08	3.945	912.221
7.892	912.826	11.978	913.484	16.362	915.087	20.656	916.844	22.573	917.394

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-60.966	.08	-41.41	.06	11.978	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-41.41	11.978	38.466	36.285	33.342	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.341

INPUT
Description: 9.7 m Upstream of the Baker Avenue Bridge
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-39.073	917.813	-29.974	914.01	-19.81	912.947	-14.929	912.563	-8.725	912.034
0	911.534	6.015	911.548	12.101	911.727	23.627	913.99	28.552	916.504

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-39.073	.08	-29.974	.06	23.627	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.

-29.974	23.627	21.193	9.7	15.476		.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.331

INPUT
Description: Upstream Face of Baker Avenue Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-32.117	917.758	-20.334	917.8	-17.123	916.333	-15.253	916.112	-11.228	914.3
-7.511	912.783	-4.079	912.097	0	911.936	6.184	912.255	8.808	912.969
12.703	914	16.471	916.319	21.197	918	27.371	918.164		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-32.117	.08	-7.511	.06	8.808	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-7.511	8.808	13.605	12.718	13.556	.1 .3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 32.325

INPUT
Description: Baker Avenue Bridge
Distance from Upstream XS = .022
Deck/Roadway Width = 12.695
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-21	917.82	916.312	-15.253	917.892	916.312	16.471	918.099	916.519
22	918	916						

Upstream Bridge Cross Section Data
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-32.117	917.758	-20.334	917.8	-17.123	916.333	-15.253	916.112	-11.228	914.3
-7.511	912.783	-4.079	912.097	0	911.936	6.184	912.255	8.808	912.969
12.703	914	16.471	916.319	21.197	918	27.371	918.164		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-32.117	.08	-7.511	.06	8.808	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-7.511	8.808	.1	.3

Downstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-18	917.82	916.3	-16.044	917.898	916.318	15.157	918.054	916.474
21	918.13	916						

Downstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

```
-30.115 917.664 -17.918  917.82 -16.044 916.118  -11.08  914.05   -7.91 913.081
 -4.192 912.516       0 912.248   3.068  912.29   6.676 913.148   9.732   914.1
 15.157 916.274  20.359 918.086

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -30.115     .08  -11.08     .06   9.732     .08

Bank Sta: Left   Right    Coeff Contr.   Expan.
        -11.08   9.732             .1       .3

Upstream Embankment side slope                =       0 horiz. to 1.0 vertical
Downstream Embankment side slope              =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins           =
Energy head used in spillway design           =
Spillway height used in design                =
Weir crest shape                              = Broad Crested

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

BRIDGE OUTPUT  Profile #100-YEAR


  E.G. US. (m)              915.40    Element                Inside BR US  Inside BR
DS
  W.S. US. (m)              915.37    E.G. Elev (m)               915.40
915.39
  Q Total (m3/s)             49.27    W.S. Elev (m)               915.37
915.35
  Q Bridge (m3/s)            49.27    Crit W.S. (m)               913.21
913.61
  Q Weir (m3/s)                       Max Chl Dpth (m)             3.43
3.10
  Weir Sta Lft (m)                    Vel Total (m/s)              0.72
0.88
  Weir Sta Rgt (m)                    Flow Area (m2)              68.09
55.70
  Weir Submerg                        Froude # Chl                 0.15
0.19
  Weir Max Depth (m)                  Specif Force (m3)           99.55
73.76
  Min El Weir Flow (m)      917.76    Hydr Depth (m)               2.39
2.06
  Min El Prs (m)            916.52    W.P. Total (m)              29.75
27.98
  Delta EG (m)                0.01    Conv. Total (m3/s)        2063.6
1595.5
  Delta WS (m)                0.02    Top Width (m)               28.52
```

27.04			
BR Open Area (m2)	86.71	Frctn Loss (m)	0.01
0.00			
BR Open Vel (m/s)	0.88	C & E Loss (m)	0.00
0.00			
Coef of Q		Shear Total (N/m2)	12.80
18.62			
Br Sel Method	Energy only	Power Total (N/m s)	-1537.70
-1441.84			

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.55	Element	Inside BR US	Inside BR
DS				
W.S. US. (m)	914.54	E.G. Elev (m)	914.55	
914.55				
Q Total (m3/s)	22.90	W.S. Elev (m)	914.54	
914.52				
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.81	
913.19				
Q Weir (m3/s)		Max Chl Dpth (m)	2.60	
2.28				
Weir Sta Lft (m)		Vel Total (m/s)	0.50	
0.65				
Weir Sta Rgt (m)		Flow Area (m2)	45.78	
35.12				
Weir Submerg		Froude # Chl	0.12	
0.16				
Weir Max Depth (m)		Specif Force (m3)	49.87	
33.57				
Min El Weir Flow (m)	917.76	Hydr Depth (m)	1.81	
1.53				
Min El Prs (m)	916.52	W.P. Total (m)	26.15	
23.63				
Delta EG (m)	0.01	Conv. Total (m3/s)	1178.9	
801.3				
Delta WS (m)	0.01	Top Width (m)	25.34	
23.01				
BR Open Area (m2)	86.71	Frctn Loss (m)	0.01	
0.00				
BR Open Vel (m/s)	0.65	C & E Loss (m)	0.00	
0.00				
Coef of Q		Shear Total (N/m2)	6.48	
11.91				
Br Sel Method	Energy only	Power Total (N/m s)	-1537.70	
-1441.84				

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.318

INPUT

Description: Downstream Face of Baker Avenue Bridge
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-30.115	917.664	-17.918	917.82	-16.044	916.118	-11.08	914.05	-7.91	913.081
-4.192	912.516	0	912.248	3.068	912.29	6.676	913.148	9.732	914.1
15.157	916.274	20.359	918.086						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-30.115	.08	-11.08	.06	9.732	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-11.08	9.732	6.645	6.753	9.156	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.311

INPUT
Description: 6.7 m Downstream of the Baker Street Bridge
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-18.944	917.652	-12.03	914.01	-8.811	911.752	-4.21	911.147	-1.36	911.957
0	911.963	5.304	912.123	7.367	912.728	14.135	913.8	15.352	914.01
27.771	917.4								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-18.944	.08	-12.03	.06	15.352	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-12.03	15.352	71.378	48.8	34.305	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.262

INPUT
Description: 55 m Downstream of the Baker Avenue Bridge
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-31.214	918.657	-26.254	917.294	-21.342	916.737	-18.211	915.342	-15.746	914.045
-12.868	913.41	-10.16	912.897	-7.915	912.419	-6.23	911.796	0	911.733
5.985	912.604	14.884	912.578	22.376	912.8	25.178	913.417	28.52	913.966
34.12	915.538	35.639	915.689						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-31.214	.08	-12.868	.06	25.178	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-12.868	25.178	75.072	71.927	67.215	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.190

INPUT
Description: Southwest of the Central Ave. and 6th Street Intersection
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-34.893	917.401	-28.897	916.829	-22.917	914.689	-17.808	913.39	-14.945	912.677
-13.232	912.576	-10.808	912.343	-4.563	911.607	0	911.306	5.431	911.993
9.537	912.365	15.924	912.791	20.603	913.475	21.448	913.812	24.026	915.02
27.702	915.044	35	915.344	43	915.644				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-34.893	.08	-17.808	.06	20.603	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-17.808	20.603	53.338	45.112	28.737	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.145

INPUT
Description: Upstream of the new 7th Street Bridge
Station Elevation Data num= 19

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-51.469	920.536	-34.983	916.888	-24.204	913.6	-17.152	912.832	-14.392	912.456
-7.806	911.91	0	911.583	7.553	911.995	17.804	912.328	24.968	912.715
29.571	913.348	34.956	912.481	41.73	912.165	48.42	913.362	51.056	915.217
55.569	915.766	65.834	915.014	71.893	916.112	78.106	916.395		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-51.469	.08	-24.204	.06	48.42	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-24.204	48.42	136.233	105.482	131.752	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-51.469	29.571	913.348	F
48.42	78.106	913.362	F

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 32.040

INPUT
Description: Downstream of the new 7th Street Bridge
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-24.979	917.618	-16.577	917.353	-11.973	915.311	-8.193	915.098	-4.396	913.45
0	911.437	2.888	911.539	8.469	911.929	10.867	912.248	12.621	912.849
13.296	913.279	14.143	914.169	25.509	914.128	37.091	914.143	49.732	913.862
62.305	913.54	77.906	913.374	89.076	913.415	102.251	913.167	113.73	913.225
130.227	913.46	134.679	915.064	141.093	916.368	141.952	920.11		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-24.979	.08	-4.396	.06	134.679	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.

-4.396 134.679 228.012 240.085 218.784 .1 .3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
-24.979	14.143	914.169	F
134.679	141.952	915.064	F

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.800

INPUT
Description: Near Hotel Pool
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-54.78	919.55	-45.903	916.731	-39.245	916.359	-33.489	913.428	-32.348	913.11
-23.534	912.079	-13.745	912.137	0	912.069	6.455	912.417	8.737	913.416
9.915	913.394	12.183	914.267	16.556	917.569	18.194	917.772		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-54.78	.08	-33.489	.06	9.915	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-33.489	9.915	47.41	56.068	61.421	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.744

INPUT
Description: 59 m Upstream of N. Culvert under Spokane Avenue
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-27.606	918.708	-21.301	916.65	-16.636	916.211	-13.566	914.459	-11.005	913.792
-10.534	913.327	-6.758	912.501	0	911.956	5.746	912.054	8.938	912.481
19.231	913.158	21.848	913.397	24.4	913.778	29.814	916.991	31.507	917.202

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-27.606	.08	-10.534	.06	21.848	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-10.534	21.848	30.463	33.958	44.91	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.710

INPUT
Description: 24 m Upstream of N. Culvert under Spokane Avenue
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-19.305	916.795	-18.101	916.106	-13.81	915.835	-8.011	913.371	-3.744	912.36
0	912.011	8.217	912.014	15.336	912.332	19.809	913.338	20.878	913.739
24.875	914.322	28.895	917.823						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-19.305	.08	-8.011	.06	19.809	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-8.011	19.809	20.119	21.179	22.681	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.689

INPUT
Description: Upstream Face of Culverts Under Spokane Avenue
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-16.036	916.5	-9.113	913.347	-6.893	912.631	0	912.42	7.383	912.431
13.908	912.821	15.532	913.382	17.658	914.455	24.273	914.6	29.145	914.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-16.036	.08	-9.113	.06	15.532	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.113	15.532	114.471	112.043	110.292	.1	.3

CULVERT

RIVER: Whitefish River
REACH: Whitefish City RS: 31.679

INPUT
Description: Upstream at Culverts under Spokane Avenue
Distance from Upstream XS = 47.496
Deck/Roadway Width = 19.934
Weir Coefficient = 2.6
Upstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-20	923.5	911	0	923.5	911	30	923.5	911

Upstream Bridge Cross Section Data
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-16.036	916.5	-9.113	913.347	-6.893	912.631	0	912.42	7.383	912.431
13.908	912.821	15.532	913.382	17.658	914.455	24.273	914.6	29.145	914.8

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-16.036	.08	-9.113	.06	15.532	.08

Bank Sta: Left	Right	Coeff Contr.	Expan.
-9.113	15.532	.1	.3

Downstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-25	923.5	911	0	923.5	911	30	923.5	911

Downstream Bridge Cross Section Data
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

```
-23.367 917.528  -9.873 913.045  -7.489 912.265  -4.115 911.993       0  911.84
  4.787 912.102   8.176 912.145  11.847 913.138  22.202 915.501  27.733     918

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
 -23.367     .08  -9.873     .06  11.847     .08

Bank Sta: Left   Right    Coeff Contr.    Expan.
        -9.873  11.847             .1        .3

Upstream Embankment side slope                =   3.296 horiz. to 1.0 vertical
Downstream Embankment side slope              =   3.126 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins           =
Energy head used in spillway design           =
Spillway height used in design                =
Weir crest shape                              = Broad Crested

Number of Culverts =  3

Culvert Name      Shape      Rise    Span
NorthCulvert     Circular   4.572
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef
Exit Loss Coef
             4.335  95.098     .024      .024         0                    .9
      1
Upstream    Elevation =  912.395
            Centerline Station = -7.518
Downstream Elevation =  912.371
            Centerline Station = -7.518

Culvert Name      Shape      Rise    Span
Cent Culvert     Circular   4.572
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef
Exit Loss Coef
             9.445  95.098     .024      .024         0                    .9
      1
Upstream    Elevation =  912.523
            Centerline Station =  0
Downstream Elevation =  912.274
            Centerline Station =  0

Culvert Name      Shape      Rise    Span
SouthCulvert     Circular   4.572
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 3 - Pipe projecting from fill
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef
Exit Loss Coef
            14.818  95.098     .024      .024         0                    .9
      1
Upstream    Elevation =  912.126
            Centerline Station =  6.573
Downstream Elevation =  912.279
            Centerline Station =  6.573

CULVERT OUTPUT  Profile #100-YEAR  Culv Group:  NorthCulvert
```

Q Culv Group (m3/s)	16.06	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.63
Q Barrel (m3/s)	16.06	Culv Vel DS (m/s)	1.71
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.40
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.37
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.12
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.12
Delta EG (m)	0.36	Culv Entr Loss (m)	0.12
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.61	Weir Sta Lft (m)	
E.G. OC (m)	915.30	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	915.04	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)	4.57	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.54	Min El Weir Flow (m)	923.50

Note: The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height of the culvert.

CULVERT OUTPUT Profile #2-YEAR Culv Group: NorthCulvert

Q Culv Group (m3/s)	7.38	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.09
Q Barrel (m3/s)	7.38	Culv Vel DS (m/s)	1.12
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.40
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.37
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.05
Delta EG (m)	0.17	Culv Entr Loss (m)	0.05
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.82	Weir Sta Lft (m)	
E.G. OC (m)	914.48	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.37	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)	2.61	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.03	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #100-YEAR Culv Group: Cent Culvert

Q Culv Group (m3/s)	15.44	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.70
Q Barrel (m3/s)	15.44	Culv Vel DS (m/s)	1.57
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.52
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.27
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.11
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.10
Delta EG (m)	0.36	Culv Entr Loss (m)	0.13
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.68	Weir Sta Lft (m)	
E.G. OC (m)	915.28	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	915.00	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)	2.02	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.50	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #2-YEAR Culv Group: Cent Culvert

Q Culv Group (m3/s)	6.92	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.14
Q Barrel (m3/s)	6.92	Culv Vel DS (m/s)	0.99
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.52
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.27
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.04
Delta EG (m)	0.17	Culv Entr Loss (m)	0.06
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.90	Weir Sta Lft (m)	
E.G. OC (m)	914.47	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.34	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)	1.32	Weir Flow Area (m2)	
Culv Crt Depth (m)	1.00	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #100-YEAR Culv Group: SouthCulvert

Q Culv Group (m3/s)	17.78	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.59
Q Barrel (m3/s)	17.78	Culv Vel DS (m/s)	1.82
E.G. US. (m)	915.30	Culv Inv El Up (m)	912.13
W.S. US. (m)	915.28	Culv Inv El Dn (m)	912.28
E.G. DS (m)	914.94	Culv Frctn Ls (m)	0.11
W.S. DS (m)	914.91	Culv Exit Loss (m)	0.14
Delta EG (m)	0.36	Culv Entr Loss (m)	0.12
Delta WS (m)	0.36	Q Weir (m3/s)	
E.G. IC (m)	914.48	Weir Sta Lft (m)	
E.G. OC (m)	915.31	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	915.07	Weir Max Depth (m)	
Culv WS Outlet (m)	914.91	Weir Avg Depth (m)	
Culv Nml Depth (m)		Weir Flow Area (m2)	
Culv Crt Depth (m)	1.62	Min El Weir Flow (m)	923.50

CULVERT OUTPUT Profile #2-YEAR Culv Group: SouthCulvert

Q Culv Group (m3/s)	8.60	Culv Full Len (m)	
# Barrels	1	Culv Vel US (m/s)	1.07
Q Barrel (m3/s)	8.60	Culv Vel DS (m/s)	1.23
E.G. US. (m)	914.48	Culv Inv El Up (m)	912.13
W.S. US. (m)	914.47	Culv Inv El Dn (m)	912.28
E.G. DS (m)	914.31	Culv Frctn Ls (m)	0.06
W.S. DS (m)	914.30	Culv Exit Loss (m)	0.07
Delta EG (m)	0.17	Culv Entr Loss (m)	0.05
Delta WS (m)	0.17	Q Weir (m3/s)	
E.G. IC (m)	913.68	Weir Sta Lft (m)	
E.G. OC (m)	914.49	Weir Sta Rgt (m)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (m)	914.38	Weir Max Depth (m)	
Culv WS Outlet (m)	914.30	Weir Avg Depth (m)	
Culv Nml Depth (m)		Weir Flow Area (m2)	
Culv Crt Depth (m)	1.11	Min El Weir Flow (m)	923.50

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.576

INPUT
Description: Downstream Face of Culverts Under Spokane Avenue
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-23.367	917.528	-9.873	913.045	-7.489	912.265	-4.115	911.993	0	911.84
4.787	912.102	8.176	912.145	11.847	913.138	22.202	915.501	27.733	918

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-23.367	.08	-9.873	.06	11.847	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.873	11.847	12.94	17.232	19.788	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.559

INPUT
Description: 17 m Downstream of Culvert under Spokane Avenue
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-37.5	919.653	-31.838	917.86	-25.25	916.726	-20.927	914.517	-15.744	913.138
-13.934	912.259	-9.968	912.335	-5.644	911.952	0	911.859	4.5	912.153
9.025	913.102	12.686	914.553	20.506	917.254	22.981	918.367		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-37.5	.08	-15.744	.06	9.025	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-15.744	9.025	28.885	28.896	31.31	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.530

INPUT
Description: 47 m Downstream of Culvert under Spokane Avenue
Station Elevation Data num= 16

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-22.461	917.173	-19.397	916.603	-14.74	914.02	-12.608	913.603	-10.714	913.087
-9.591	912.563	-6.311	911.996	0	911.768	4.214	911.806	8.182	912.505
9.84	913.078	11.813	914.093	17.281	915.301	20.432	916.423	34.384	922.651
37.853	922.902								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-22.461	.08	-10.714	.06	9.84	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-10.714	9.84	68.247	69.304	67.842	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.461

INPUT
Description: 62 m Upstream of Columbia Avenue Bridge
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-29.852	918.87	-24.281	918.121	-10.065	914.157	-7.374	913.02	-4.378	912.424
0	911.592	4.446	911.629	8.758	912.644	12.112	913.018	19.82	915.813
24.946	917.242	38.64	922.8	42.331	922.898				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-29.852	.08	-7.374	.06	12.112	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-7.374	12.112	56.222	62.106	69.432	.1	.3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.399

INPUT
Description: Upstream Face of Columbia Avenue Bridge
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-38.956	920.163	-34.901	919.687	-26.179	916.097	-18.181	913.155	-12.739	912.565
-11.354	912.371	-6.328	912.088	0	912.231	8.048	913.106	19.395	916.785
25.522	920.077	37.118	920.723						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-38.956	.08	-18.181	.06	8.048	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-18.181	8.048	12.192	11.204	12.083	.1	.3

BRIDGE

RIVER: Whitefish River
REACH: Whitefish City RS: 31.393

INPUT
Description: Columbia Avenue Bridge
Distance from Upstream XS = 1.3
Deck/Roadway Width = 9.903
Weir Coefficient = 1.44
Upstream Deck/Roadway Coordinates
num= 8

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-39	920.218	912	-32.003	920.218	912	-32.003	920.218	918.49
-7.09	920.2	918.472	-5.566	920.2	918.472	22.615	920.178	918.45
22.615	920.178	912	26	920.178	912			

Upstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-38.956	920.163	-34.901	919.687	-26.179	916.097	-18.181	913.155	-12.739	912.565
-11.354	912.371	-6.328	912.088	0	912.231	8.048	913.106	19.395	916.785
25.522	920.077	37.118	920.723						

```
Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -38.956     .08 -18.181     .06   8.048     .08

Bank Sta: Left   Right    Coeff Contr.    Expan.
       -18.181   8.048             .1        .3

Downstream  Deck/Roadway Coordinates
    num=        8
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
      -39 920.188     912 -31.082 920.188     912 -31.082 920.188  918.46
  -6.343 920.163 918.435  -4.819 920.163 918.435  23.266 920.144 918.416
  23.266 920.144     912      26 920.144     912

Downstream Bridge Cross Section Data
Station Elevation Data    num=       17
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
 -36.798 920.229 -31.272 920.189 -27.467 917.356 -23.436 916.002 -22.925 914.511
   -15.6 913.067 -10.801 912.293  -5.657 912.401       0 912.195   10.83 912.683
  12.844 913.007  18.248 914.735  23.289  917.37  23.348 920.144  28.441  919.96
  32.056 920.582  36.436 920.837

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 -36.798     .08   -15.6     .06  12.844     .08

Bank Sta: Left   Right    Coeff Contr.    Expan.
         -15.6  12.844             .1        .3

Upstream Embankment side slope                   =       0 horiz. to 1.0 vertical
Downstream Embankment side slope                 =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow      =     .95
Elevation at which weir flow begins              =
Energy head used in spillway design              =
Spillway height used in design                   =
Weir crest shape                                 = Broad Crested

Number of Piers =  1

Pier Data
Pier Station     Upstream=  -6.328    Downstream=  -5.581
Upstream     num=        2
    Width    Elev    Width    Elev
    1.524     912    1.524 918.472
Downstream     num=        2
    Width    Elev    Width    Elev
    1.524     912    1.524 918.435

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
```

BRIDGE OUTPUT Profile #100-YEAR

E.G. US. (m)	914.81	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.78	E.G. Elev (m)	914.81	914.80
Q Total (m3/s)	49.27	W.S. Elev (m)	914.78	914.77
Q Bridge (m3/s)	49.27	Crit W.S. (m)	913.25	913.17
Q Weir (m3/s)		Max Chl Dpth (m)	2.67	2.58
Weir Sta Lft (m)		Vel Total (m/s)	0.77	0.66
Weir Sta Rgt (m)		Flow Area (m2)	63.80	74.20
Weir Submerg		Froude # Chl	0.18	0.15
Weir Max Depth (m)		Specif Force (m3)	72.89	82.78
Min El Weir Flow (m)	920.11	Hydr Depth (m)	1.86	1.86
Min El Prs (m)	918.49	W.P. Total (m)	40.25	45.32
Delta EG (m)	0.01	Conv. Total (m3/s)	1490.7	1756.9
Delta WS (m)	0.01	Top Width (m)	34.27	39.81
BR Open Area (m2)	227.37	Frctn Loss (m)	0.01	0.00
BR Open Vel (m/s)	0.77	C & E Loss (m)	0.00	0.00
Coef of Q		Shear Total (N/m2)	16.98	12.63
Br Sel Method	Energy only	Power Total (N/m s)	-1865.13	-1761.81

BRIDGE OUTPUT Profile #2-YEAR

E.G. US. (m)	914.24	Element	Inside BR US	Inside BR DS
W.S. US. (m)	914.23	E.G. Elev (m)	914.24	914.23
Q Total (m3/s)	22.90	W.S. Elev (m)	914.23	914.22
Q Bridge (m3/s)	22.90	Crit W.S. (m)	912.91	912.87
Q Weir (m3/s)		Max Chl Dpth (m)	2.12	2.03
Weir Sta Lft (m)		Vel Total (m/s)	0.50	0.43
Weir Sta Rgt (m)		Flow Area (m2)	45.77	52.95
Weir Submerg		Froude # Chl	0.13	0.11
Weir Max Depth (m)		Specif Force (m3)	39.91	45.38

Min El Weir Flow (m)	920.11	Hydr Depth (m)	1.47
1.45			
Min El Prs (m)	918.49	W.P. Total (m)	35.75
40.68			
Delta EG (m)	0.01	Conv. Total (m3/s)	933.6
1098.5			
Delta WS (m)	0.00	Top Width (m)	31.07
36.59			
BR Open Area (m2)	227.37	Frctn Loss (m)	0.01
0.00			
BR Open Vel (m/s)	0.50	C & E Loss (m)	0.00
0.00			
Coef of Q		Shear Total (N/m2)	7.55
5.55			
Br Sel Method	Energy only	Power Total (N/m s)	-1865.13
-1761.81			

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.388

INPUT
Description: Downstream Face of Columbia Avenue Bridge
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-36.798	920.229	-31.272	920.189	-27.467	917.356	-23.436	916.002	-22.925	914.511
-15.6	913.067	-10.801	912.293	-5.657	912.401	0	912.195	10.83	912.683
12.844	913.007	18.248	914.735	23.289	917.37	23.348	920.144	28.441	919.96
32.056	920.582	36.436	920.837						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-36.798	.08	-15.6	.06	12.844	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-15.6	12.844	17.995	14.752	11.664	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.373

INPUT
Description: 15 m Downstream of the Columbia Ave. Bridge
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-18.111	915.69	-11.714	915.38	-7.916	912.8	-3.647	912.26	0	912.27
5.27	912.44	11.356	912.77	18.171	914.4	23.601	917.65		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-18.111	.08	-7.916	.06	11.356	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-7.916	11.356	20.012	20.377	27.386	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.353

INPUT
Description: 35 m Downstream of Columbia Ave. Bridge
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-24.182	916.34	-19.958	915.02	-15.919	912.69	-13.645	912.08	-9.925	911.9
-5.188	911.84	0	911.76	6.541	911.72	8.414	912.26	13.521	911.87
16.254	912.79	22.897	914.4	28.383	917.29				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-24.182	.08	-15.919	.06	16.254	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-15.919	16.254	42.287	41.107	41.181	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.312

INPUT
Description: 76 m Downstream of Columbia Avenue Bridge
Station Elevation Data num= 14

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-28.997	917.694	-23.743	917.179	-17.424	913.598	-13.986	913.028	-13.47	912.501
-10.692	910.915	-4.89	908.906	0	908.524	9.086	910.211	17.925	912.269
23.944	912.971	27.838	914.976	37.507	918.038	40.695	918.824		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-28.997	.08	-13.986	.06	23.944	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-13.986	23.944	182.801	151.975	105.156	.1 .3

CROSS SECTION

RIVER: Whitefish River
REACH: Whitefish City RS: 31.160

INPUT
Description: 228 m Downstream of Columbia Avenue Bridge
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
-21.387	914.759	-14.194	914.356	-9.883	913.027	-6.03	912.151	0	912.071
9.494	912.105	18.166	912.404	21.988	913.022	26.652	917.034		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
-21.387	.08	-9.883	.06	21.988	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
-9.883	21.988	0	0	0	.1 .3

SUMMARY OF MANNING'S N VALUES

River:Whitefish River

Reach	River Sta.	n1	n2	n3
Whitefish City	34.304	.08	.06	.08
Whitefish City	33.98	.08	.06	.08
Whitefish City	33.976	Bridge		
Whitefish City	33.972	.08	.06	.08
Whitefish City	33.639	.08	.06	.08
Whitefish City	33.408	.08	.06	.08
Whitefish City	33.293	.08	.06	.08
Whitefish City	33.155	.08	.06	.08
Whitefish City	33.131	.08	.06	.08
Whitefish City	33.110	Bridge		
Whitefish City	33.101	.08	.06	.08
Whitefish City	32.586	.08	.06	.08
Whitefish City	32.584	Bridge		
Whitefish City	32.582	.08	.06	.08
Whitefish City	32.490	.08	.06	.08
Whitefish City	32.377	.08	.06	.08
Whitefish City	32.341	.08	.06	.08
Whitefish City	32.331	.08	.06	.08
Whitefish City	32.325	Bridge		
Whitefish City	32.318	.08	.06	.08
Whitefish City	32.311	.08	.06	.08
Whitefish City	32.262	.08	.06	.08
Whitefish City	32.190	.08	.06	.08
Whitefish City	32.145	.08	.06	.08
Whitefish City	32.040	.08	.06	.08
Whitefish City	31.800	.08	.06	.08
Whitefish City	31.744	.08	.06	.08
Whitefish City	31.710	.08	.06	.08
Whitefish City	31.689	.08	.06	.08
Whitefish City	31.679	Culvert		
Whitefish City	31.576	.08	.06	.08
Whitefish City	31.559	.08	.06	.08
Whitefish City	31.530	.08	.06	.08
Whitefish City	31.461	.08	.06	.08
Whitefish City	31.399	.08	.06	.08
Whitefish City	31.393	Bridge		
Whitefish City	31.388	.08	.06	.08
Whitefish City	31.373	.08	.06	.08
Whitefish City	31.353	.08	.06	.08
Whitefish City	31.312	.08	.06	.08
Whitefish City	31.160	.08	.06	.08

SUMMARY OF REACH LENGTHS

River: Whitefish River

Reach	River Sta.	Left	Channel	Right
Whitefish City	34.304	337.355	325.924	331.97
Whitefish City	33.98	8.002	8.002	8.002
Whitefish City	33.976	Bridge		
Whitefish City	33.972	328.925	329.729	343.158
Whitefish City	33.639	184.125	230.908	267.49
Whitefish City	33.408	133.292	115.036	97.73
Whitefish City	33.293	140.339	138.399	126.853

Whitefish City	33.155	25.946	23.816	15.636
Whitefish City	33.131	39.731	29.985	26.656
Whitefish City	33.110	Bridge		
Whitefish City	33.101	493.525	515.055	526.652
Whitefish City	32.586	4	4	4
Whitefish City	32.584	Bridge		
Whitefish City	32.582	85.305	92.817	98.174
Whitefish City	32.490	96.592	113.278	118.871
Whitefish City	32.377	38.466	36.285	33.342
Whitefish City	32.341	21.193	9.7	15.476
Whitefish City	32.331	13.605	12.718	13.556
Whitefish City	32.325	Bridge		
Whitefish City	32.318	6.645	6.753	9.156
Whitefish City	32.311	71.378	48.8	34.305
Whitefish City	32.262	75.072	71.927	67.215
Whitefish City	32.190	53.338	45.112	28.737
Whitefish City	32.145	136.233	105.482	131.752
Whitefish City	32.040	228.012	240.085	218.784
Whitefish City	31.800	47.41	56.068	61.421
Whitefish City	31.744	30.463	33.958	44.91
Whitefish City	31.710	20.119	21.179	22.681
Whitefish City	31.689	114.471	112.043	110.292
Whitefish City	31.679	Culvert		
Whitefish City	31.576	12.94	17.232	19.788
Whitefish City	31.559	28.885	28.896	31.31
Whitefish City	31.530	68.247	69.304	67.842
Whitefish City	31.461	56.222	62.106	69.432
Whitefish City	31.399	12.192	11.204	12.083
Whitefish City	31.393	Bridge		
Whitefish City	31.388	17.995	14.752	11.664
Whitefish City	31.373	20.012	20.377	27.386
Whitefish City	31.353	42.287	41.107	41.181
Whitefish City	31.312	182.801	151.975	105.156
Whitefish City	31.160	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Whitefish River

Reach	River Sta.	Contr.	Expan.
Whitefish City	34.304	.1	.3
Whitefish City	33.98	.1	.3
Whitefish City	33.976	Bridge	
Whitefish City	33.972	.1	.3
Whitefish City	33.639	.1	.3
Whitefish City	33.408	.1	.3
Whitefish City	33.293	.1	.3
Whitefish City	33.155	.1	.3
Whitefish City	33.131	.1	.3
Whitefish City	33.110	Bridge	
Whitefish City	33.101	.1	.3
Whitefish City	32.586	.1	.3
Whitefish City	32.584	Bridge	
Whitefish City	32.582	.1	.3
Whitefish City	32.490	.1	.3
Whitefish City	32.377	.1	.3
Whitefish City	32.341	.1	.3
Whitefish City	32.331	.1	.3
Whitefish City	32.325	Bridge	

Whitefish City	32.318		.1	.3
Whitefish City	32.311		.1	.3
Whitefish City	32.262		.1	.3
Whitefish City	32.190		.1	.3
Whitefish City	32.145		.1	.3
Whitefish City	32.040		.1	.3
Whitefish City	31.800		.1	.3
Whitefish City	31.744		.1	.3
Whitefish City	31.710		.1	.3
Whitefish City	31.689		.1	.3
Whitefish City	31.679	Culvert		
Whitefish City	31.576		.1	.3
Whitefish City	31.559		.1	.3
Whitefish City	31.530		.1	.3
Whitefish City	31.461		.1	.3
Whitefish City	31.399		.1	.3
Whitefish City	31.393	Bridge		
Whitefish City	31.388		.1	.3
Whitefish City	31.373		.1	.3
Whitefish City	31.353		.1	.3
Whitefish City	31.312		.1	.3
Whitefish City	31.160		.1	.3

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : Plan 04

River: Whitefish River Reach: Whitefish City RS: 34.304 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 34.304 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.972 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.972 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.639 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 33.639 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.582 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.341 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.341 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream

conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.325 Profile: 2-YEAR Upstream
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.318 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.318 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.190 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.190 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 32.145 Profile: 100-YEAR
Warning:Divided flow computed for this cross-section.
River: Whitefish River Reach: Whitefish City RS: 32.145 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 32.040 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 32.040 Profile: 2-YEAR
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Whitefish River Reach: Whitefish City RS: 31.800 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.800 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.710 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.679 Profile: 100-YEAR
Culv: NorthCulvert
Note: The normal depth exceeds the height of the culvert. The program assumes that the normal depth is equal to the height
of the culvert.
River: Whitefish River Reach: Whitefish City RS: 31.388 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.388 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream

conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.373 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.373 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.353 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.353 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.312 Profile: 100-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Whitefish River Reach: Whitefish City RS: 31.312 Profile: 2-YEAR
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

APPENDIX E
Known Water Surface Calculations

WGM GROUP
PLANNING | SURVEYING | ENGINEERING | DESIGN

DATE: NOVEMBER 30, 2011
PROJECT ID: WHITEFISH WEST
SHEET #: 01 OF:
TYPE OF COMPUTATION: KNOWN WATER SURFACE
CALCULATED BY: KLT CHECKED BY:

FIRST CROSS SECTION (RS 31.160) IS LOCATED 228 METERS DOWNSTREAM OF THE COLUMBIA AVENUE BRIDGE.

FROM THE FLATHEAD COUNTY FIS (SEPT. 28, 2007), COLUMBIA AVE. IS LOCATED AT RS 103,689 FT.

THE FIS REFERENCED RS AT CROSS SECTION 31.160 (STUDY) IS:

$$103{,}689 \text{ FT} - 228 \text{ m} \left(\frac{\text{FT.}}{0.3048 \text{ m}}\right) = 102{,}940 \text{ FT.}$$

DETERMINE THE WATER SURFACE ELEVATION OF THE 1% ANNUAL CHANCE FLOOD EVENT AT RS 102,940 FT.

RS 102,940 IS BETWEEN CROSS SECTIONS A AND B OF THE FIS FLOODWAY DATA TABLE.

THE WATER SURFACE SLOPE BETWEEN CROSS SECTIONS A AND B IS:

$$S = \frac{3001.1 - 3000.9}{103{,}200 - 102{,}000} = 1.667 \times 10^{-4} \text{ FT/FT}$$

THE WATER SURFACE ELEVATION AT 102,940 FT IS:

$$WS = 3000.9 + (102{,}940 - 102{,}000)\, 1.667 \times 10^{-4}$$

$$= 3{,}001.057 \text{ FT} \left(\frac{0.3048 \text{ m}}{\text{FT}}\right)$$

$$= 914.722 \text{ M} \quad \text{USE } \boxed{914.72 \text{ m}}$$

1111 E. BROADWAY MISSOULA, MT 59802 TEL: 406-728-4611 FAX: 406-728-2476

FILE: 030413 SUB: HY NO:

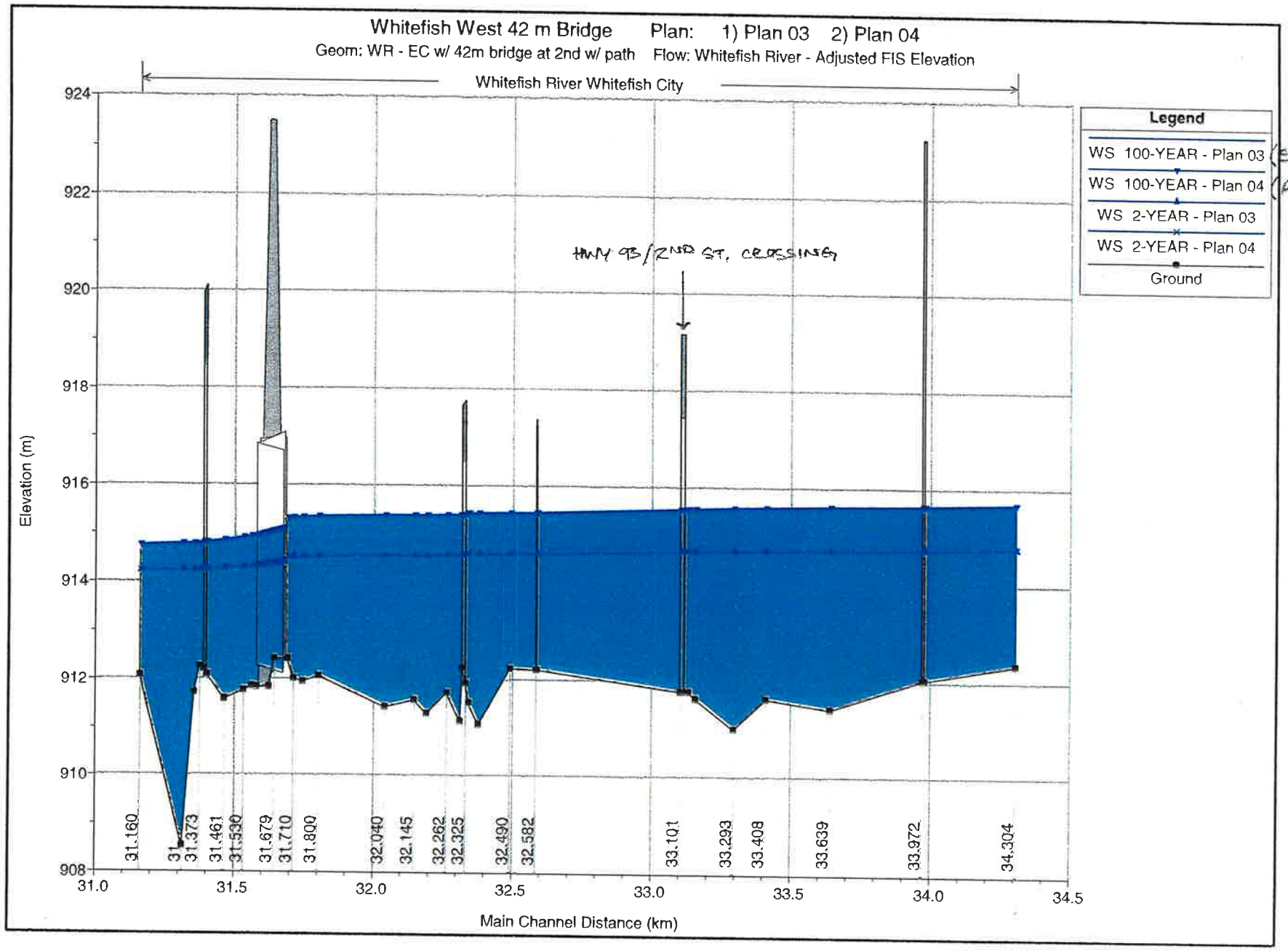
APPENDIX F
Historical Imagery

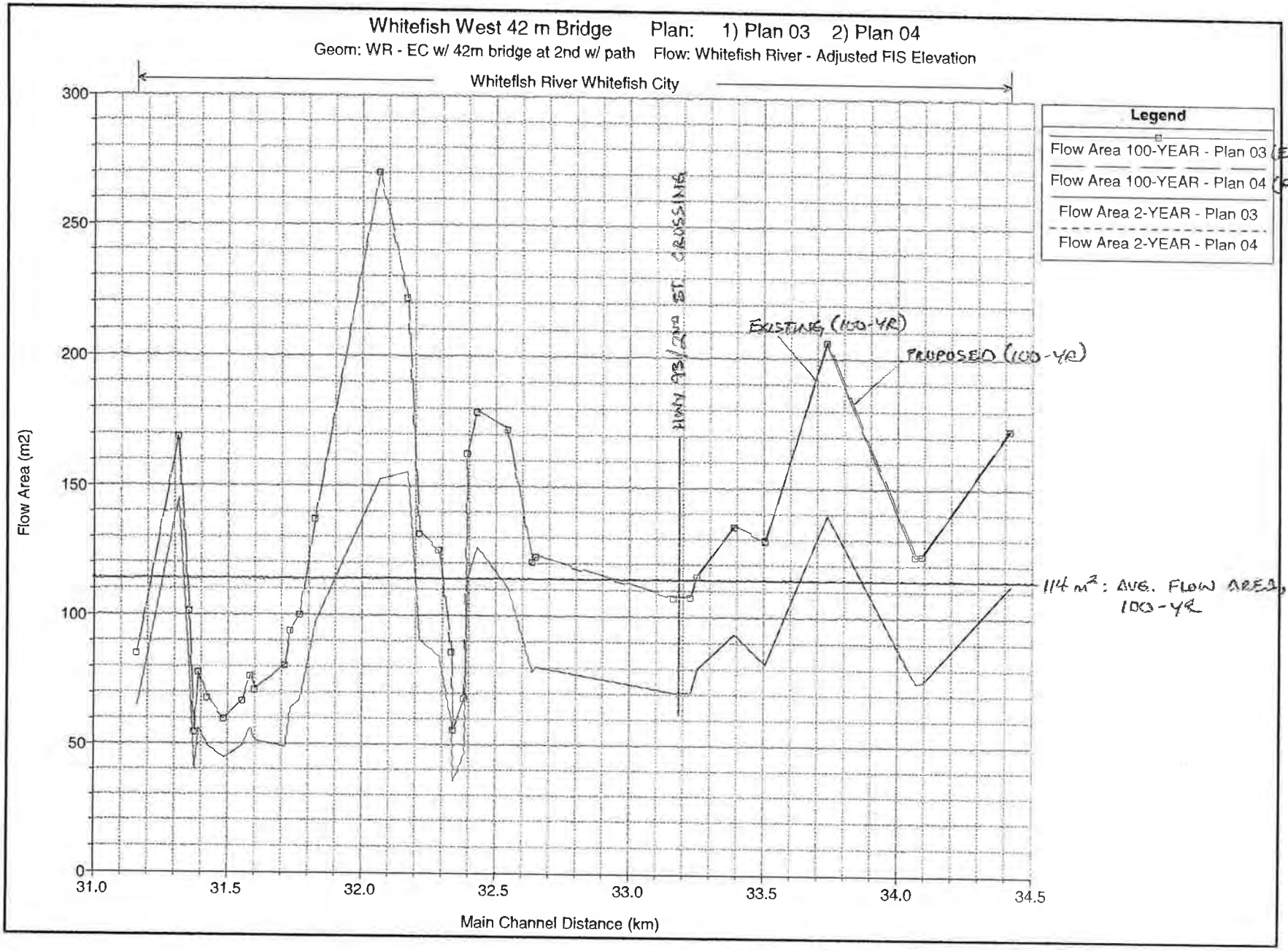
Image date: 6/30/1990

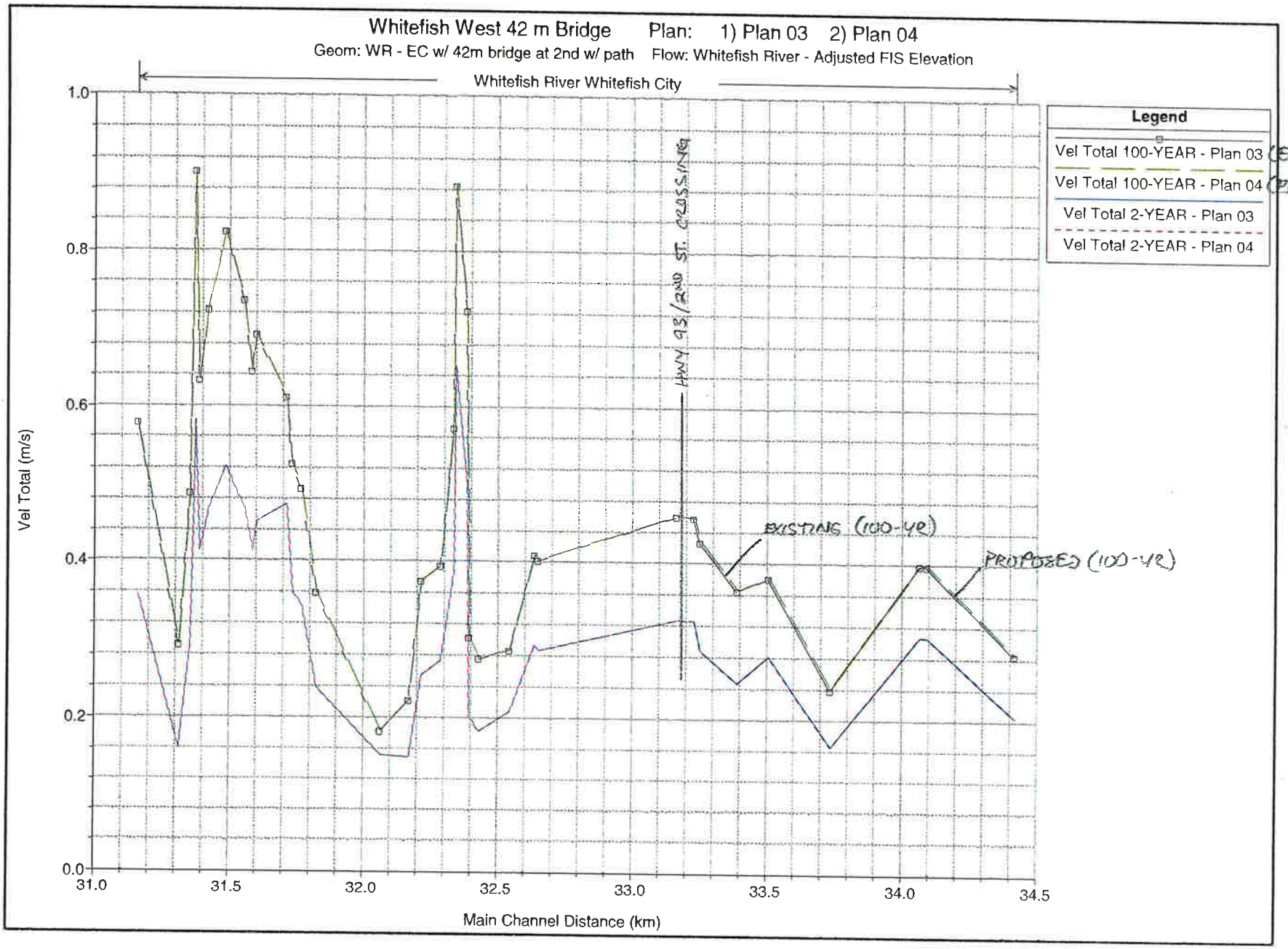
Image date: 5/23/2004

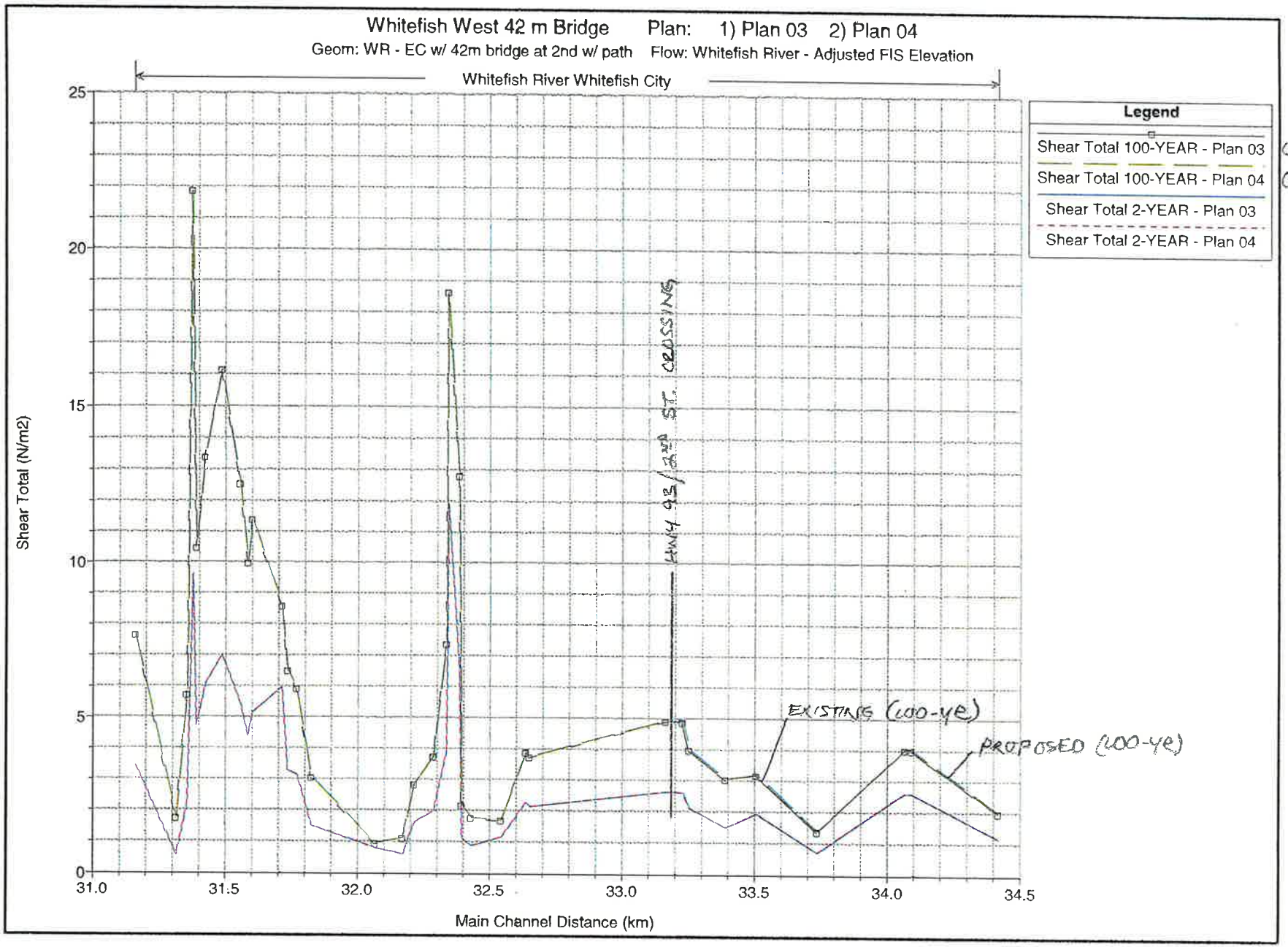
Image date: 9/1/2009

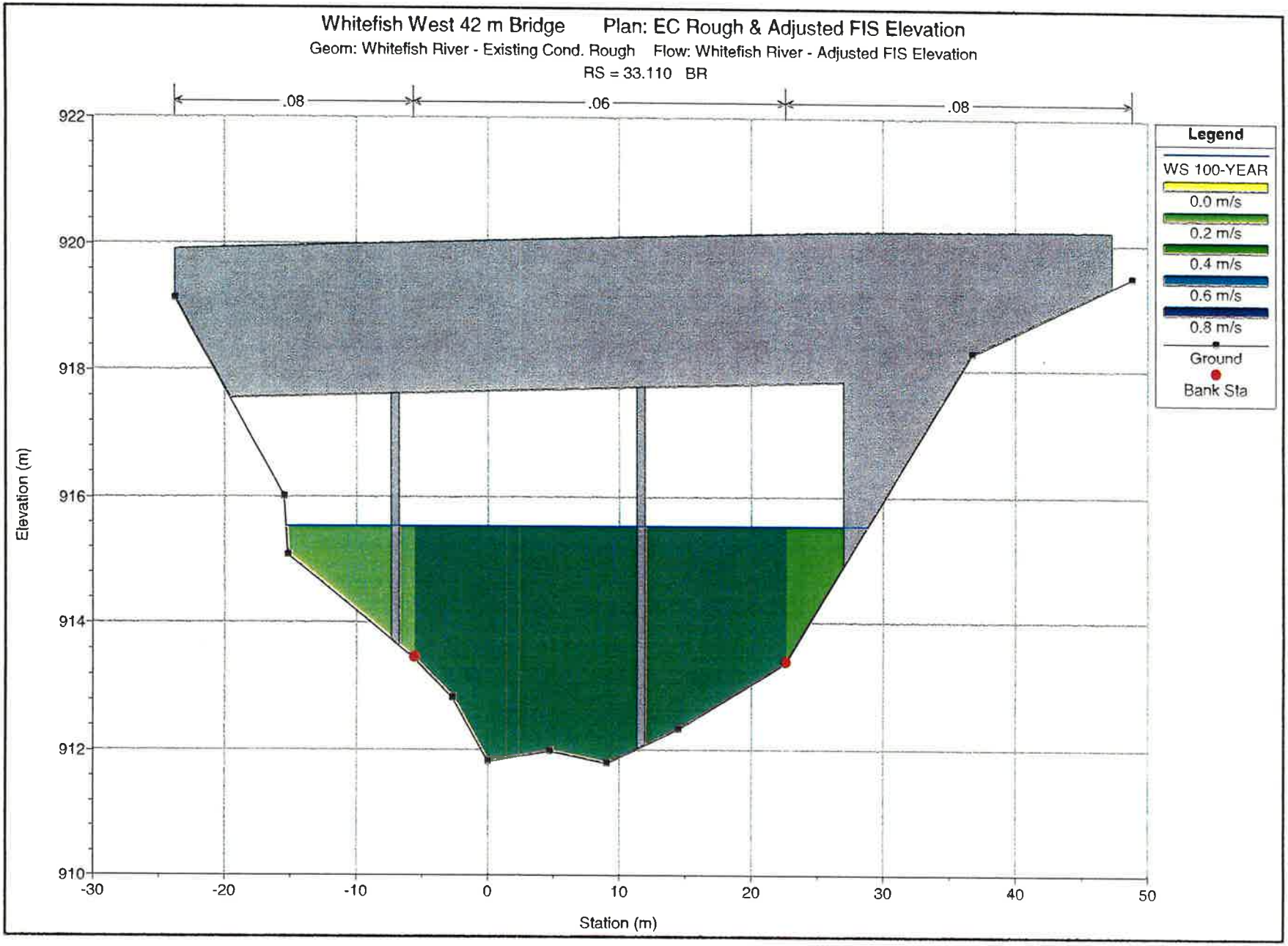
APPENDIX G
HEC-RAS Profile and Velocity Distribution Plots

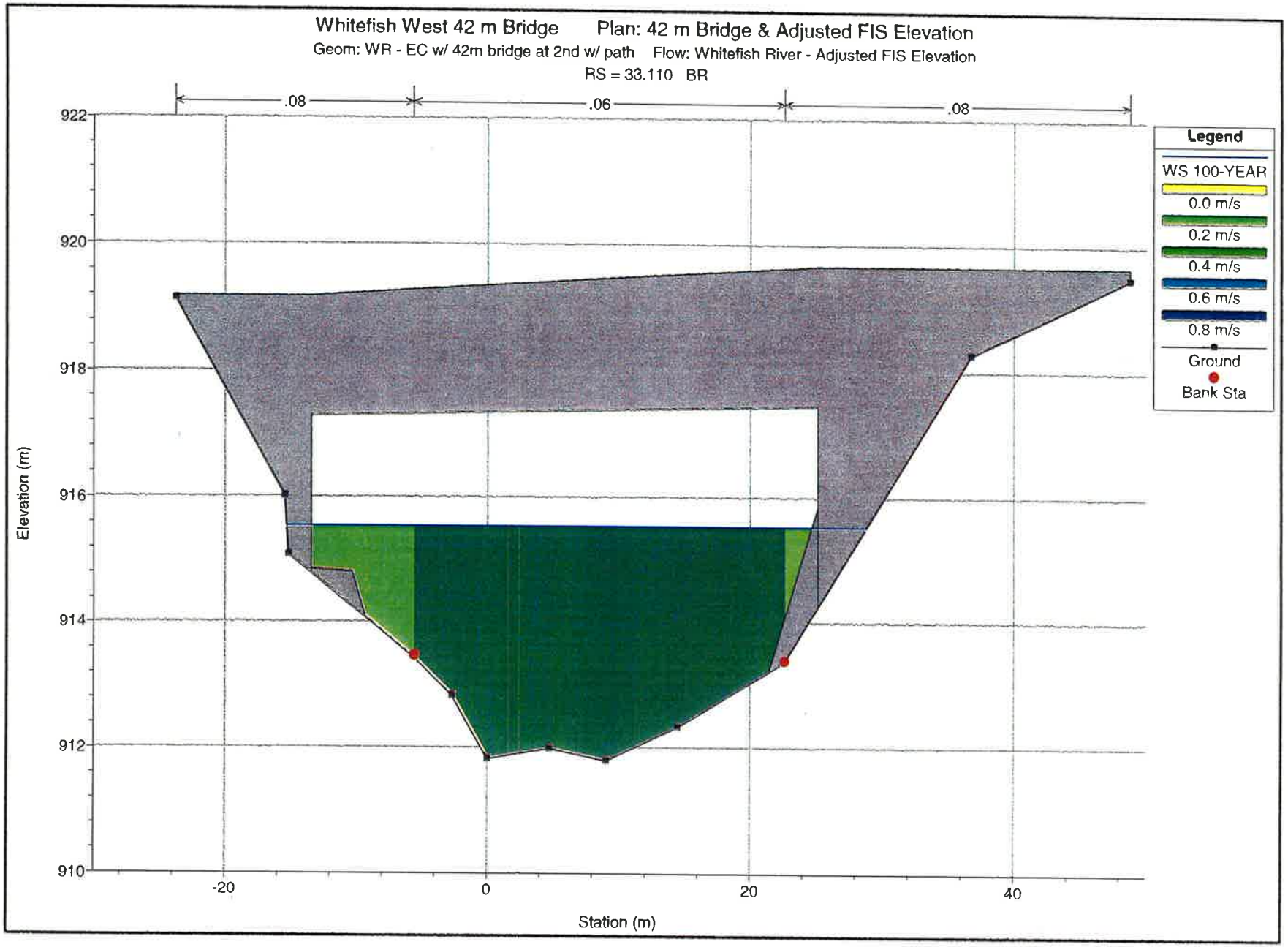

Whitefish West 42 m Bridge
Plan: 1) Plan 03 2) Plan 04
Geom: WR - EC w/ 42m bridge at 2nd w/ path
Flow: Whitefish River - Adjusted FIS Elevation
Whitefish River Whitefish City
HWY 93/2ND ST. CROSSING
Legend
WS 100-YEAR - Plan 03 (EXISTING)
WS 100-YEAR - Plan 04 (PROPOSED)
WS 2-YEAR - Plan 03
WS 2-YEAR - Plan 04
Ground
Elevation (m)
924
922
920
918
916
914
912
910
908
31.160
31.373
31.461
31.530
31.679
31.710
31.800
32.040
32.145
32.262
32.325
32.490
32.582
33.101
33.293
33.408
33.639
33.972
34.304
31.0
31.5
32.0
32.5
33.0
33.5
34.0
34.5
Main Channel Distance (km)


Whitefish West 42 m Bridge Plan: 1) Plan 03 2) Plan 04
Geom: WR - EC w/ 42m bridge at 2nd w/ path Flow: Whitefish River - Adjusted FIS Elevation
Whiteflsh River Whitefish City
Legend
Flow Area 100-YEAR - Plan 03 (EXISTING)
Flow Area 100-YEAR - Plan 04 (PROPOSED)
Flow Area 2-YEAR - Plan 03
Flow Area 2-YEAR - Plan 04
HWY 93 / 2nd ST. CROSSING
EXISTING (100-YR)
PROPOSED (100-YR)
114 m²: AVG. FLOW AREA, 100-YR
Flow Area (m2)
Main Channel Distance (km)
0
50
100
150
200
250
300
31.0
31.5
32.0
32.5
33.0
33.5
34.0
34.5


Whitefish West 42 m Bridge Plan: 1) Plan 03 2) Plan 04
Geom: WR - EC w/ 42m bridge at 2nd w/ path Flow: Whitefish River - Adjusted FIS Elevation
Whitefish River Whitefish City
HWY 93/2ND ST. CROSSING
EXISTING (100-YR)
PROPOSED (100-YR)
Legend
Vel Total 100-YEAR - Plan 03 (EXISTING)
Vel Total 100-YEAR - Plan 04 (PROPOSED)
Vel Total 2-YEAR - Plan 03
Vel Total 2-YEAR - Plan 04
Vel Total (m/s)
1.0
0.8
0.6
0.4
0.2
0.0
31.0
31.5
32.0
32.5
33.0
33.5
34.0
34.5
Main Channel Distance (km)


Whitefish West 42 m Bridge Plan: 1) Plan 03 2) Plan 04
Geom: WR - EC w/ 42m bridge at 2nd w/ path Flow: Whitefish River - Adjusted FIS Elevation
Whitefish River Whitefish City
Legend
Shear Total 100-YEAR - Plan 03
Shear Total 100-YEAR - Plan 04
Shear Total 2-YEAR - Plan 03
Shear Total 2-YEAR - Plan 04
(EXISTING)
(PROPOSED)
HWY 93 / 2ND ST. CROSSING
EXISTING (100-YR)
PROPOSED (100-YR)
Shear Total (N/m2)
Main Channel Distance (km)
0
5
10
15
20
25
31.0
31.5
32.0
32.5
33.0
33.5
34.0
34.5


Whitefish West 42 m Bridge Plan: EC Rough & Adjusted FIS Elevation
Geom: Whitefish River - Existing Cond. Rough Flow: Whitefish River - Adjusted FIS Elevation
RS = 33.110 BR
.08
.06
.08
Legend
WS 100-YEAR
0.0 m/s
0.2 m/s
0.4 m/s
0.6 m/s
0.8 m/s
Ground
Bank Sta
Elevation (m)
922
920
918
916
914
912
910
-30
-20
-10
0
10
20
30
40
50
Station (m)


Whitefish West 42 m Bridge
Plan: 42 m Bridge & Adjusted FIS Elevation
Geom: WR - EC w/ 42m bridge at 2nd w/ path
Flow: Whitefish River - Adjusted FIS Elevation
RS = 33.110 BR
.08
.06
.08
922
920
918
916
914
912
910
Elevation (m)
-20
0
20
40
Station (m)
Legend
WS 100-YEAR
0.0 m/s
0.2 m/s
0.4 m/s
0.6 m/s
0.8 m/s
Ground
Bank Sta

APPENDIX H
Scour and Riprap Calculations

Thomas, Dean & Hoskins, Inc.
TD&H
Engineering Consultants

GRADATION
SIEVE ANALYSIS

WHITEFISH RIVER
SCOUR

JOB: WGM
JOB # 03-086
PROJECT: WHITEFISH WEST
DATE: 28-Feb-07
TESTING REQUIRED ON SAMPLE T-11 GRADATION, T-27
INSPECTO TLS

SAMPLE GROSS WT., WET (gm)	7753.0
SAMPLE GROSS WT., DRY (gm)	7753.0
CONTAINER TARE WEIGHT (gm)	562.0
NET WEIGHT SAMPLE (gm)	7191.0

SAMPLE % MOISTURE .....

% SAMPLE PASSING #200 ..... 6.0

seive size	3"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	#4
weight retained	0.0	219.0	130.0	174.0	473.0	546.0	773.0	488.0
percent retained	0.0	3.0	1.8	2.4	6.6	7.6	10.7	6.8
percent passing	100.0	97.0	95.2	92.8	86.2	78.6	67.9	61.1
specifi-cation								

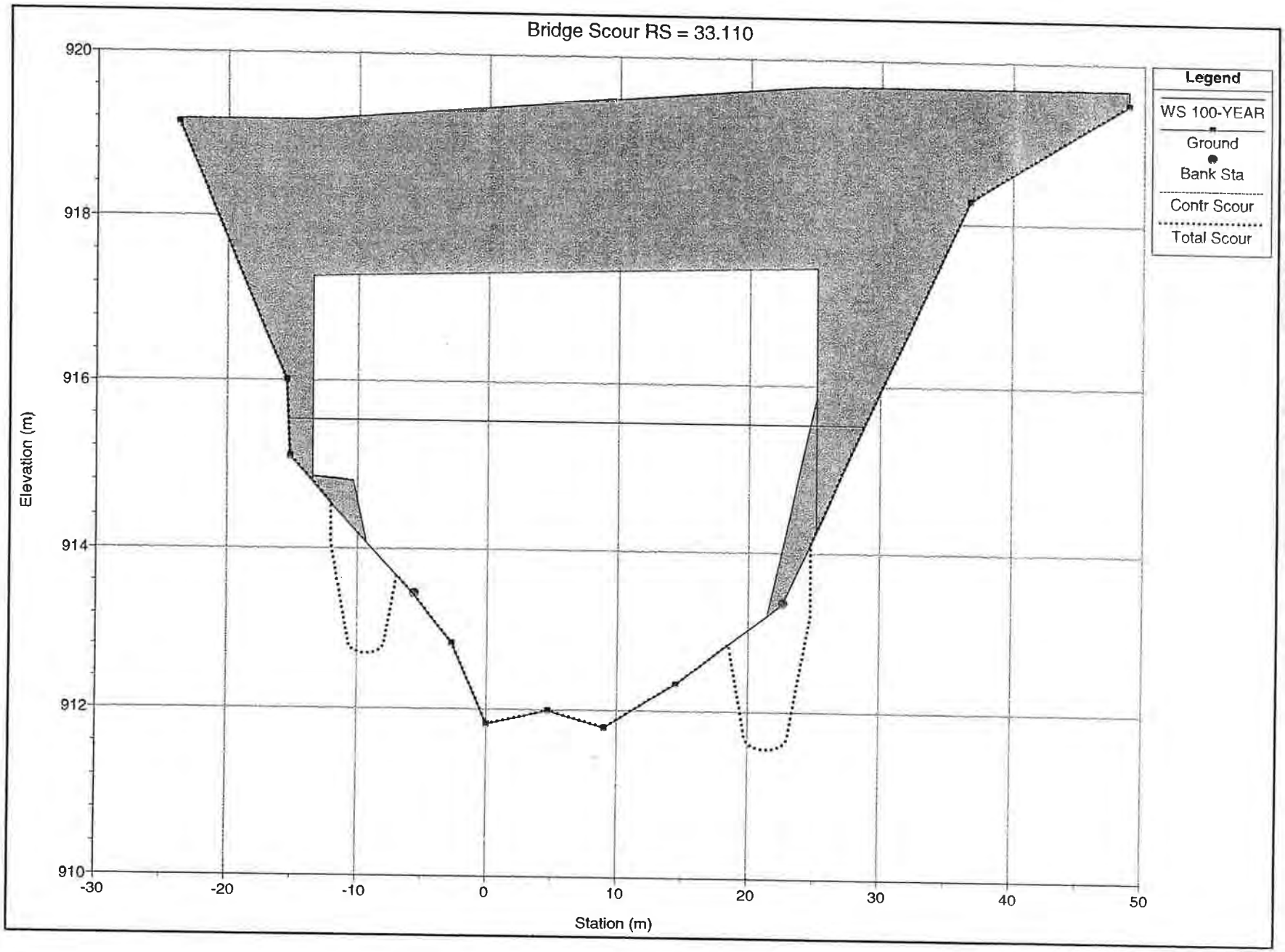
seive size	#8	#10	#16	#30	#40	#80	#100	#200
weight retained	920.0	196.0	566.0	788.0	471.0	761.0	112.0	147.0
percent retained	12.8	2.7	7.9	11	6.5	10.6	1.6	2.0
percent passing	48.3	45.6	37.7	26.7	20.2	9.6	8.0	6.0
specifi-cation								

Contraction Scour

Input Data	Left	Channel	Right
Average Depth (m):	1.14	3.19	0.80
Approach Velocity (m/s):	0.16	0.45	0.13
Br Average Depth (m):	1.24	3.13	0.73
BR Opening Flow (m3/s):	1.97	47.10	0.20
BR Top WD (m):	7.79	28.24	2.07
Grain Size D50 (mm):	2.40	2.40	2.40
Approach Flow (m3/s):	0.83	47.72	0.72
Approach Top WD (m):	4.52	32.86	6.84
K1 Coefficient:	0.590	0.590	0.590
Results			
Scour Depth Ys (m):	0.00	0.00	0.00
Critical Velocity (m/s):			
Equation:	Clear	Clear	Clear

Abutment Scour

Input Data	Left	Right
Station at Toe (m):	-9.28	21.40
Toe Sta at appr (m):	-12.87	22.44
Abutment Length (m):	1.31	8.03
Depth at Toe (m):	1.45	2.30
K1 Shape Coef:	0.55 - Spill-through abutment	
Degree of Skew (degrees):	109	71
K2 Skew Coef:	1.03	0.97
Projected Length L' (m):	1.24	7.59
Avg Depth Obstructed Ya (m):	1.14	1.07
Flow Obstructed Qe (m3/s):	0.24	1.96
Area Obstructed Ae (m2):	1.50	8.62
Results		
Scour Depth Ys (m):	1.38	1.67
Qe/Ae = Ve:	0.16	0.23
Froude #:	0.05	0.07
Equation:	Froehlich	Froehlich


Bridge Scour RS = 33.110
Legend
WS 100-YEAR
Ground
Bank Sta
Contr Scour
Total Scour
Elevation (m)
920
918
916
914
912
910
-30
-20
-10
0
10
20
30
40
50
Station (m)

GIVEN: DATA FROM HEC-RAS MODEL; "FINAL HYDRAULICS REPORT BRIDGE ANALYSIS"

FIND: ① EXISTING CHANNEL AS LIVE-BED SCOUR OR CLEAR WATER SCOUR (BOTH CONTRACTION SCOUR)

② CONTRACTION SCOUR DEPTH

③ CHANNEL BOTTOM SHEAR STRESS AND RIPRAP SIZE

④ SIDE SLOPE SHEAR STRESS AND RIPRAP SIZE

SOLN:

① DETERMINE CRITICAL VELOCITY FOR EXISTING BED MATERIAL

$$V_c = K_u\, y^{1/6} D_{50}^{1/2}$$

$K_u = 6.19\ m^{1/2}/s$

y = FLOW DEPTH/HYDR. DEPTH (m)

$D_{50} = 0.00236$ m

LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK
$y_L = 1.14$ m	$y_{CH} = 3.19$ m	$y_R = 0.80$ m
$V_{c(L)} = 6.19(1.14)^{1/6}(2.36\times10^{-3})^{1/3}$	$V_{c(CH)} = 0.8241(3.19)^{1/6}$	$V_{c(R)} = 0.8241(0.80)^{1/6}$
$V_{c(L)} = 0.84$ m/s	$V_{c(CH)} = 1.0$ m/s	$V_{c(R)} = 0.79$ m/s

COMPARE V_c TO $V_{AVG.}$ FOR SECTION RS 53.155

$V_L = 0.16$ m/s	$V_{CH} = 0.45$ m/s	$V_R = 0.13$ m/s
$V_c > V_L$ ∴	$V_c > V_{CH}$ ∴	$V_c > V_R$ ∴
CLEAR-WATER SCOUR	CLEAR-WATER SCOUR	CLEAR-WATER SCOUR

② DETERMINE CLEAR WATER CONTRACTION SCOUR DEPTH

$$y_s = \left(\frac{Q_{BU}^2}{C_u\, D_m^{(2/3)}\, W_{BU}^2}\right)^{3/7} - y_{BU}$$

Q_{BU} = FLOW (m^3/s)

y_{BU} = HYDR. DEPTH (m)

$C_u = 40\ m/s^2$

$D_m = 1.25\, D_{50}$
$= 2.95\times10^{-3}$ m

W_{BU} = TOP WIDTH (m)

LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK
$Q_{EU(L)} = 2.38\ m^3/s$	$Q_{EU(CH)} = 46.87\ m^3/s$	$Q_{EU(R)} = 0.01\ m^3/s$
$W_{EU(L)} = 8.46\ m$	$W_{EU(CH)} = 28.24\ m$	$W_{EU(R)} = 0.78\ m$
$Y_{EU(L)} = 1.25\ m$	$Y_{EU(CH)} = 3.05\ m$	$Y_{EU(R)} = 0.26\ m$
$Y_{S(L)} = \left(\frac{2.38^2}{0.823\,(8.46)^2}\right)^{3/7} - Y_{EU}$	$Y_{S(CH)} = \left(\frac{46.87^2}{0.823\,(28.24)^2}\right)^{3/7} - Y_{EU}$	$Y_{S(R)} = \left(\frac{0.01^2}{0.823\,(0.78)^2}\right)^{3/7} - Y_{EU}$
$= -0.88\ m$	$= -1.37\ m$	$= -0.17\ m$
$\therefore$ NO SCOUR	$\therefore$ NO SCOUR	$\therefore$ NO SCOUR

CONTRACTION SCOUR NOT ANTICIPATED

③ DETERMINE CHANNEL SHEAR STRESS AND RIPRAP SIZE (RS BR U)

IN ORDER FOR RIPRAP TO BE STABLE $\tau_p \geq SF\,\tau_d$

$\tau_p = F_* (\gamma_s - \gamma) D_{50}$

F_* = SHIELDS PARAMETER (TABLE 6.1)

$\gamma_s = 25{,}900\ N/m^3$

$\gamma = 9810\ N/m^3$

$D_{50} = 0.66\ FT = 0.201\ m$

DETERMINE SHIELDS PARAMETER:
CALCULATE REYNOLDS NUMBER

$R_e = \frac{V_* D_{50}}{\nu}$

V_* = SHEAR VELOCITY
$= (gdS)^{1/2}$

$g = 9.81\ m/s^2$

d = MAX. CHANNEL DEPTH
$= 3.72\ m$

S = CHANNEL SLOPE
$= 0.000250\ m/m$

$V_* = 0.096\ m/s$

ν = KINEMATIC VISCOSITY
$= 1.131 \times 10^{-6}\ m^2/s$ (@ 15.5° C)

$$R_e = \frac{0.096\ m/s\ (6.201\ m)}{1.131 \times 10^{-6}\ m^2/s}$$

$$= 1.70 \times 10^4$$

FROM TABLE 6.1, $R_e \leq 4 \times 10^4$, $F_x = 0.047$ AND SF = 1.0

$\tau_p = 0.047\ (25{,}900 - 9810)\ 0.201\ m$

$= 152\ N/m^2$

$\tau_d = \gamma d S_o$

$\gamma = 9810\ N/m^3$

$d = 3.72\ m$

$S_o = 0.000250\ m/m$ (APPROXIMATED AS E.G. SLOPE)

$\tau_d = 9.12\ N/m^2$

$\tau_p \geq 1.0\ \tau_d$ ∴ CLASS I RIPRAP OKAY

④ DETERMINE SIDE SLOPE SHEAR STRESS AND RIPRAP SIZE

$\tau_s = K_1 \tau_d$

K_1 = RATIO OF CHANNEL SIDE TO BOTTOM SHEAR STRESS;

$K_1 = 0.77$ $Z \leq 1.5$

$K_1 = 0.0662Z + 0.67$ $1.5 < Z \leq 5$

$K_1 = 1.0$ $5 \leq Z$

Z = HORIZONTAL DIM. (1:Z)

FOR 2ND ST. BRIDGE, Z = 1.5

$\tau_s = 0.77\ (9.12\ N/m^2)$

$= 7.02\ N/m^2$

$D_{50,s} = \frac{K_1}{K_2} D_{50,b}$

$K_1 = 0.77$

$K_2 = \left[1 - \left(\frac{\sin\theta}{\sin\phi}\right)^2\right]^{1/2}$

$\theta = \tan^{-1}\left(\frac{1}{Z}\right)$

$= \tan^{-1}\left(\frac{1}{1.5}\right)$

$= 33.69°$

Φ = ANGLE OF REPOSE (FIGURE 6.1)
= 41.5° (ASSUME VERY ANGULAR STONE)

$$K_2 = \left[1 - \left(\frac{\sin 33.7}{\sin 41.5}\right)^2\right]^{1/2}$$

$$= 0.55$$

$$D_{50,s} = \frac{0.77}{0.55} D_{50,b}$$

$$D_{50,b} = \frac{SF(d)S_0}{F_*(SG-1)}$$

$SF = 1.0$
$d = 3.72\ m$
$S_0 = 0.000250\ m/m$
$F_* = 0.047$
$SG = \gamma_s/\gamma = 2.64$

$$D_{50,b} = \frac{1.0(3.72)0.000250}{0.047(2.64-1.0)}$$

$$= 0.012\ m$$

$$D_{50,s} = 1.40(0.012\ m)$$

$$= 0.017\ m \quad \therefore \text{ CLASS I RIPRAP OKAY}$$

FOR PROBLEMS ① AND ②, REFERENCE CHAPTER 7 FROM "OPEN CHANNEL HYDRAULICS" BY A. OSMAN AKAN, 2006

FOR PROBLEMS ③ AND ④, REFERENCE CHAPTERS 5 AND 6 FROM "DESIGN OF ROADSIDE CHANNELS WITH FLEXIBLE LININGS", HEC 15, 3RD. EDITION.

Riprap Computations, Whitefish River, Second Street Bridge

For Froude Number < 0.8, use Isbash Equation

Abutments:

$D_{50} = (K/(S-1))*(V^2/g)$
Where K = 0.89 for Spillthrough Abutments

Parameter	50-Year	100-Year	500-Year
K	0.89	0.89	0.89
S (SG)	2.65	2.65	2.65
V	0.46	0.48	0.52
g	9.81	9.81	9.81
D_{50}	0.01	0.01	0.01

Piers:

$D_{50} = (0.6928(KV)^2)/((S-1)*2g)$
Where K = 1.5 for Round Nose Pier

Parameter	50-Year	100-Year	500-Year
K	1.5	1.5	1.5
S	2.65	2.65	2.65
V	0.46	0.48	0.52
g	9.81	9.81	9.81
D_{50}	0.01	0.01	0.01

MDT Standard Riprap Sizes:

Class 1, D_{50} = 0.20 m
Class 2, D_{50} = 0.40 m
Class 3, D_{50} = 0.60 m